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**THE THEORETICAL AND EXPERIMENTAL
INVESTIGATIONS ON MULTIPLE
PURE TONE NOISE - PART I**

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Prepared by

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16. Abstract A theoretical and experimental investigation is described on multiple pure tone noise. Based on a two-dimensional and inviscid flow model, an analysis is developed to predict the generation and subsequent evolution of multiple pure tone noise from prescribed blade-to-blade nonuniformities in the rotor geometry. The results show that even small nonuniformities within manufacturing tolerances can cause a significant amount of multiple pure tone noise. Among the different kinds of nonuniformities investigated, errors in blade spacings are a weaker generator of multiple pure tone noise than errors in blade stagger or blade contours. Experimental investigations of the effects of the rotor relative Mach number, incidence angle and length of the inlet duct on the evolution of the multiple pure tone noise are conducted with a known distribution of rotor nonuniformities. The model fan is operated, in Freon 12, in a closed loop acoustical facility. In order to compare the analysis with the experimental results, the MPT distributions are computed from the known blade nonuniformities of the model fan. Due to the difficulty of measuring the blade contour on blades only 0.59 inches long, the important MPT contribution due to contour nonuniformity is not included. For this reason an exact comparison between theoretical and experimental results is not achieved. However, the computed result correctly predicts the position of the maximum peak of multiple pure tones in the frequency spectrum and predicts a sound pressure of the blade passing frequency noise that is in the same range as the experimental values.					
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FOREWORD

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TABLE OF CONTENTS

	<u>Page Number</u>
LIST OF FIGURES	vii
LIST OF TABLES	x
1.0 INTRODUCTION	1
2.0 ANALYSIS	3
2.1 Problem Statement and Assumptions	3
2.2 Outline of Analysis	4
2.3 Comparison with Hawkings' Method	5
3.0 RESULTS OF ANALYSIS	7
3.1 Ideal Uniform Blades -- Decay Rate of Shock Strength	7
3.2 Nonuniform Blade Geometry	7
3.2.1 Effects of Blade Spacing Errors	7
3.2.2 Effects of Stagger Error	8
4.0 MPT EXPERIMENTS	9
4.1 Introduction	9
4.2 Test Compressor	9
4.3 Experimental Facility	10
4.3.1 Test Loop	10
4.3.2 Aerodynamic Instrumentation	11
4.3.3 Acoustic Instrumentation	11
4.4 Experimental Results	13
4.4.1 Rotor Imperfections	13
4.4.2 Aerodynamic Performance	13
4.4.3 Acoustic Tests	14
4.4.3.1 Microphone Calibration	14
4.4.3.2 Acoustic Data Reduction Methods	14
4.4.3.3 Blade Passing Frequency Results - Long Inlet Duct	15
4.4.3.4 MPT Distribution - Long Inlet Duct	16
4.4.3.5 Plenum Measurements	17

4.4.4	Experimental Summary	19
4.4.4.1	Long Inlet Duct	19
4.4.4.2	Short Versus Long Inlet Duct	19
4.4.5	Comparison Between Theory and Experiments	20
5.0	CONCLUSIONS AND RECOMMENDATIONS	22
	REFERENCES	24
Appendix 1.	Description of Computer Program "MPT"	74
Appendix 2.	Listing of Program "MPT"	79
Appendix 3.	Sample Input and Output	101

LIST OF FIGURES

Figure 1	Wave Systems for Idealized Uniform-Bladed Rotor.	25
Figure 2	Computed Decay of Shock Strength for an Ideal Uniform Cascade.	26
Figure 3	Measured Decay of Shock Strength (Fig. 14 of Ref. 2).	26
Figure 4(a)	Effect of Blade Spacing Errors (Error Distribution, A-1 of Table 2).	27
Figure 4(b)	Effect of Blade Spacing Errors (Error Distribution, A-2 of Table 2).	28
Figure 5(a)	Effect of Stagger Errors (Error Distribution, B-1 of Table 3).	29
Figure 5(b)	Effect of Stagger Errors (Error Distribution, B-2 of Table 3).	30
Figure 6	Change of Pressure Profiles.	31
Figure 7	Scale Model Rotor.	32
Figure 8	Rotor Blade Geometry.	33
Figure 9	Compressor Layout.	34
Figure 10	Schematic of Test Loop with Inlet Plenum.	35
Figure 11	Rotor Nonuniformities.	36
Figure 12	Model Compressor Performance Map.	37
Figure 13	Incidence Angle Versus Mach Number.	38
Figure 14	Calibration Curve of the Plenum Microphone.	39
Figure 15	Spectral Analyzer CRT Output Characteristics.	40
Figure 16	BPF Noise Versus Axial Distance.	41
Figure 17	BPF Noise Versus Axial Distance.	42
Figure 18	BPF Noise Versus Axial Distance.	43
Figure 19	BPF Noise Versus Relative Mach Number.	44
Figure 20	BPF Noise Versus Relative Mach Number.	45
Figure 21	BPF Noise Versus Relative Mach Number.	46

Figure 22	Wall Static Pressure Traces in the Long Inlet Duct.	47
Figure 23	Wall Static Pressure Traces in the Long Inlet Duct.	48
Figure 24	Wall Static SPL Spectrum, BPF = 13.25 KHz, High Flow, Flow Conditions - $M_r = 1.094$, $\alpha = 5.9^\circ$.	49
Figure 25	Wall Static SPL Spectrum, BPF = 13 KHz, Intermediate Flow, Flow Conditions - $M_r = 1.056$, $\alpha = 7.6^\circ$.	50
Figure 26	Wall Static SPL Spectrum, BPF = 13 KHz, Near Stall, Flow Conditions - $M_r = 1.037$, $\alpha = 9.6^\circ$.	51
Figure 27	Wall Static SPL Spectrum, BPF = 14 KHz, High Flow, Flow Conditions - $M_r = 1.158$, $\alpha = 5.4^\circ$.	52
Figure 28	Wall Static SPL Spectrum, BPF = 14 KHz, Intermediate Flow, Flow Conditions - $M_r = 1.144$, $\alpha = 6.7^\circ$.	53
Figure 29	Wall Static SPL Spectrum, BPF = 14 KHz, Near Stall, Flow Conditions - $M_r = 1.128$, $\alpha = 8.65^\circ$.	54
Figure 30	Wall Static SPL Spectrum, BPF = 15.1 KHz, High Flow, Flow Conditions - $M_r = 1.26$, $\alpha = 5.1^\circ$.	55
Figure 31	Wall Static SPL Spectrum, BPF = 15.1 KHz, Intermediate Flow, Flow Conditions - $M_r = 1.245$, $\alpha = 5.96^\circ$.	56
Figure 32	Wall Static SPL Spectrum, BPF = 15.1 KHz, Near Stall, Flow Conditions - $M_r = 1.226$, $\alpha = 7.6^\circ$.	57
Figure 33	Plenum BPF Noise Versus Mach Number.	58
Figure 34	MPT Noise Versus Axial Distance, Low Speed.	59
Figure 35	MPT Noise Versus Axial Distance, Intermediate Speed.	60
Figure 36	MPT Noise Versus Axial Distance, High Speed.	61
Figure 37	Plenum SPL Spectrum, Short Inlet, BPF = 13 KHz, Microphone Steady.	62
Figure 38	Plenum SPL Spectrum, Short Inlet, BPF = 14 KHz, Microphone Steady.	63
Figure 39	Plenum SPL Spectrum, Short Inlet, BPF = 15.1 KHz, Microphone Steady.	64

Figure 40	Computed Evolution of MPY for Model Rotor.	65
Figure 41	Coordinate System.	66
Figure 42	Structure of Program "MPT".	68

LIST OF TABLES

Table 1.	Cascade Geometry and Tolerances.	67
Table 2.	Blade Spacing Errors Distribution.	69
Table 3.	Stagger Errors Distribution.	70
Table 4.	Acoustic Summary - Long Inlet.	71
Table 5.	Acoustic Summary - Plenum.	72
Table 6.	Input Data for MPT Computation of Experimental Rotor.	73

1.0 INTRODUCTION

In recent years the reduction of jet engine noise has been dramatic. These improvements have largely been concentrated on the blade passing frequencies and their higher harmonics. The contributions of these components has been so reduced that attention is now being focused on the next most objectionable sound emanating from the jet engine, that is, the multiple pure tone sound.

Multiple pure tone sound from aircraft engines is characterized by its noise spectra containing numerous spikes at shaft rotational frequency. Often some of the spikes prevail over the spikes at blade passing frequency and are thus quite audible. The response of human ears to multiple pure tone sound (abbreviated as MPT sound) is distinctly different from the response to blade passing frequency sound. Most people hear blade passing frequency sound as a shrill whine. MPT is perceived as a much lower tone and more ragged type of sound. MPT is also called "buzz saw" sound because it is allegedly similar to the sound from a circular buzz saw.

Recently published works of Kester (Ref. 1), Sofrin and Pickett (Ref. 2) and Philpot (Ref. 3) experimentally established the essential features of the MPT. First, the MPT sound from the current fan begins to dominate over the blade passing frequency sound when the relative tip speed of the fan exceeds sonic velocity. Second, it radiates only from the inlet duct of the fan and not out of the discharge duct. Third, and most important of all, the MPT signal is highly repetitive over each revolution of the rotor. These observed characteristics of the MPT suggests strongly that bow shock waves from fan tip are responsible for the generation of the MPT. Refs. 1 and 2 present convincing evidence that this is indeed the cause.

When the relative Mach number of the fan tip exceeds unity, bow shocks emanate from the leading edge of each blade and, as long as the axial velocity remains subsonic, one branch of bow shocks propagates away from and upstream of the rotor. These bow shocks are locked to and spinning with the rotor. In the absence of any geometric aberration of the blade, the bow shocks would be spatially uniform in strength and spacing (except for the monotonic attenuation with distance from the rotor). However, references 1 and 2 report that the pressure pattern in the compressor casing indicates an increasingly nonuniform shock pattern with increasing axial distance upstream of the rotor plane. Since the shock waves are spinning with the rotor, a stationary observer is swept by this shock pattern irregular both in spacings and strength but repetitive at each revolution of rotor. Thus the fundamental harmonic of such a sound is at the rotor frequency.

Were the shock patterns uniform, the fundamentals would be at the blade passing frequency. The causes of such irregular shock pattern amplification has been suggested to be the non-uniformity in the geometry of the blades in an actual fan. Although this is the most plausible explanation, it appears not to be positively confirmed. Manufacturing tolerances of conventional fans are usually very small and it is therefore a legitimate question to ask whether such small non-uniformities in the blades could be responsible for the generation and evolution of MPT. MPT sound does exist even in subsonic fans if the fan blades are designed deliberately to be nonuniform. However, in order to obtain substantial MPT sound, the nonuniformity of the blade has to be so large that sometimes they impair the other requirements.

The specific objectives of the present investigation are as follows:

(1) First, to confirm both analytically and experimentally, whether the lack of uniformity of blade geometry within the manufacturing tolerances are responsible for the MPT sound.

(2) Second, to determine whether different types of nonuniformities can be characterized by their effect on the generation of the MPT sound.

(3) Third, to determine the effect of the relative Mach number and the flow angle on the evolution of the MPT sound.

(4) Fourth, to determine the effect of the inlet duct length on the MPT sound generation.

In the section immediately following, section 2, the analytical method of MPT prediction is described. Section 3 presents the results based on the analysis. Section 4 discusses the experimental approach and facilities. Section 5 presents the conclusions and recommendation for future work.

2.0 ANALYSIS

2.1 Problem Statement and Assumptions

The problem to be analyzed may be posed as follows:

Given a rotor with blades of known geometrical non-uniformities, compute the pressure field upstream of the rotor.

To repeat the final objective, the goal is to examine if the small errors within the manufacturing tolerances are responsible for the MPT.

Needless to say, simplifications are needed to grapple with the above problem and the following assumptions are adopted:

- (1) There are no inlet guide vanes.
- (2) The bow shocks are attached to the leading edges of the blades.
- (3) The flow field can be approximated by a two-dimensional model.
- (4) The diffusive effects due to viscosity and heat conductivity are neglected.

Some remarks are needed to justify assumptions (3) and (4). A question might be raised as to the validity of two-dimensional assumption (3) in the conventional supersonic fan design where relative Mach number near the hub is still subsonic. According to the theoretical study performed by McCune (Refs. 4 and 5), the three-dimensional effects for such fans are so large that strip theory is hardly adequate. However, diagonally opposite experimental evidence, which seems to lend support to the present assumption, was presented in Ref. 2 where three-dimensional effects were investigated. By inserting an annular sleeve in the vicinity of the tip, they eliminated interference in the radial direction. Comparison between the shock patterns with the evolution of irregular shock patterns. Support of assumption (4) is also found in Ref. 2. According to their measurements, starting from a chord length or so away from the rotor, the decay rate of average shock strength was found to be inversely proportional to the axial distance. According to Blackstock (Ref. 6) this decay rate is precisely that which can be predicted by treating the flow everywhere as nondissipative (with the exception of inside the shock wave) provided the axial distance from the rotor is not too large; whereas a dissipative model should show exponential decay. Therefore it seems that assumption (4) is valid provided the attention

is restricted to the near and intermediate field region of the rotor. It is a fortuitous circumstance that despite the fact that the wall boundary layer along the outer casing exists in the vicinity of the tip shock, these dissipative effects on the shock decay at the outer edge of the boundary layers are negligible.

2.2 Outline of Analysis

Basically the whole analysis consists of the construction of shock-expansion wave diagram upstream of rotor. Complications arise because of mutual interference between blades. Before considering how to estimate the effects of blade nonuniformity on the wave system, it is instructive to consider the wave system for the ideal rotor without any asymmetry. Fig. 1 shows the wave system for such an idealized rotor and the description of the wave system is given in Reference 7. Since the grasp of the wave system for the idealized rotor is vital to the understanding of the next step, it is summarized below. As seen in Figure 1, part of the expansion fans emanating from the suction surface between A and C interact with the shock wave generated from the same blade, while the rest of the expansion fans between C and B interact with the shock wave emerging from the adjacent blade. The dividing Mach line C - C is the only wave not intercepted by the shock and extends to infinity. Point C is that location on the blade the tangent of which is parallel to the velocity direction at infinity. If we cannot find a surface tangent parallel to the velocity direction at infinity, this is an unsteady condition and after the transient emission of an expansion fan at the leading edge, the velocity at infinity adjusts itself until the proper conditions are established on the suction surface. The trajectory of the curved shock can be determined by locally applying oblique shock relations. The conditions ahead and behind the shock are known from the Prandtl-Meyer relation.

Having once grasped the above, it is immediately clear how to examine the nonuniform blade arrangement. We need only identify the change of position C from one blade to another due to the change in the geometry between blades. The rest is exactly the same as the idealized symmetrical rotor.

A computer program was written with which the wave diagram may be constructed. As the sources of nonuniformity, the following blade-to-blade errors were considered.

- (1) Spacing between blades,
- (2) Stagger angle, and
- (3) Blade contour near the leading edge.

Given the distribution of these errors and the flow conditions far upstream as inputs, the program provides such outputs as the pressure distribution, its harmonic components and bow shock trajectories as functions of axial distance. The detailed description of the program is given in Appendix 1. We will present here only a few points pertinent to the wave construction procedure utilized.

Referring to Fig. 1 again, once point C is located on the first blade, the expansion fans between C and B can be constructed immediately. The expansion fan B intersects the leading edge of the 2nd blade, A'. From the wedge angle of the second blade, the initial shock shape can be constructed as A'P'. The flow immediately downstream of the shock (in the region 1) is also known. Now, according to the considerations at the beginning of this section, the flow in region 1 must accelerate and attain Mach number at infinity at point C' where again the tangent to the blade is parallel to the velocity far upstream. This might seem to be true only if the shock is extremely weak. However it turns out that this holds true even if the wedge angle is moderately large, say, 10 degrees or so. This results from the fact that reflection of the expansion wave by the shock is small and confirms the validity of locating point C' (and C) by the aforementioned principle. Resuming the procedure of determining bow shock trajectory, the next segment P'Q' can be determined by finding the oblique shock satisfying the known upstream and downstream conditions. The same process determines the complete wave system between two adjacent blades. There is one small salient point to be made here. In as much as in the downstream region (say, region 2) not only the flow direction but the velocity is known and the shock is determined solely by specifying either one of them, it appears that the problem is overdetermined and some conflicting results might show up by the particular choice of downstream condition between the two. Actually it turns out the choice is insignificant so long as the shock remains moderate in strength. In the computer program, the flow direction is taken as the known downstream condition.

2.3 Comparison with Hawkings' Method

After the completion of the present investigation, a recently published analysis of MPT by Hawkings (Ref. 8) came to the attention of the present investigators. Although the basic physical model of the shock-expansion fan interference and the assumptions are the same, there appears to be distinct differences between the two approaches. Hawkings' approach is essentially a one dimensional (plane), unsteady shock analysis, whereas the present method is a two-dimensional (non-planar), steady shock analysis. According to Hawkings, if one takes a direction normal to the average shock fronts,

theory of one-dimensional shock propagation is then applied to describe their time history. The time, of course, is related to the axial distance. In the present analysis, the shock is treated as two-dimensional. Although the shocks are actually two-dimensional because of their curvatures and blade-to-blade differences, one-dimensional assumption of Hawkings is probably a reasonably good one. Such an approach has the advantage of being able to preserve the analytical expressions up to the advanced stages of computation. The most crucial difference between the two methods are the following: In the Hawkings' analysis, the initial nonuniformity of pressure profile has to be specified in order to obtain the history of shock propagation and the relation between the non-uniform pressure profile and the nonuniform blade geometry has to be guessed by some indirect means. In the present analysis, it is unnecessary to specify the initial pressure profile which results as a part of the answer once the nonuniformity of blade geometry is specified. Since, as emphasized before, the kernel of the supersonic MPT problem is to investigate whether small errors within the manufacturing tolerances are really responsible for MPT generation, it would seem that the present analysis answers the question in a more direct way.

3.0 RESULTS OF THE ANALYSIS

Utilizing the analysis described in Section 2, sample computations were conducted and these will be presented herein. The cascade geometry and the blade shape chosen is given in Table 1.

3.1 Ideal Uniform Blades -- Decay Rate of Shock Strength

As far as the MPT sound is concerned, the case of the uniform bladed rotor is of no particular consequence. However such an idealized case provides a good check on the entire analysis. Figure 2 is a plot of the decay of the shock strength for an ideally uniform cascade versus axial distance. It is readily observed that there is a change over in the decay rate. In the vicinity of the rotor the decay is gradual, at a rate approximately proportional to the inverse square root of the distance. After a transition in the neighborhood of one blade spacing ahead of the rotor, the decay rate becomes approximately inversely proportional to distance. According to Blackstock, (Ref. 6), this inverse decay rate is what can be expected with the inviscid model in the intermediate region between the close near field of the rotor and the far field. An interesting comparison can be made between Figure 2 and Figure 14 of Ref. 2, which is reproduced here as Figure 3. In Figure 3, the shock strength is an average shock strength measured from the actual fan. Thus the measured decay rate of an individual shock reflects the blade-to-blade non-uniformity but the average decay rate can be considered to be close to the ideal uniform blade case. The nominal spacing of the fan blades is about 2.8 inches. It is seen that the two different decay rate and their transitional point agrees quite well with the computed results.

3.2 Nonuniform Blade Geometry

3.2.1 Effects of Blade Spacing Errors

At this point only the effect of blade spacing errors in the absence of other nonuniformities will be considered. Figure 4 shows the growth of MPT in the two cases of spacing error distribution. The two different error distributions are given in Table 2. It is easily seen that even at a distance of five blade spacings ahead of the rotor, the MPT is still less than the blade passing frequency in intensity. Since the experimental results show that MPT intensities exceed BPF at about two or three blade spacings ahead of rotor, it would appear that spacing errors per se are insignificant in MPT generation. This is in contradiction to the speculation of Ffowcs-Williams (Ref. 9), where the error in circumferential positioning is one of the essential features of MPT. The answer to the question as to which is correct cannot be provided by the experimental fan simply because actual fans contain

other nonuniformities which tend to mask, as will be seen shortly, the spacing error effects.

3.2.2 Effects of Stagger Errors

Figure 5 shows the effect of stagger errors in the two cases of stagger error distributions. The two different error distributions are given in Table 3. At three blade spacing ahead of rotor, some MPT harmonics begin to prevail over BPF harmonics and this trend agrees with the observations (Refs. 1 and 2). The plot of pressure profiles, Figure 6, shows the change of pressure profiles at three different axial locations. Close to the rotor, the shocks are more or less uniform both in strength and spacings but away from the rotor, they become very irregular. Such a trend is also well established by experiments (Refs. 1 and 2). Therefore it would seem safe to conclude that stagger errors are important MPT generators. Physically there are two mechanisms of MPT generation. First, since the airfoil shape of the supersonic fan is nearly a flat plate, even a small change in the stagger can cause appreciable positional change of point C of Figure 1 along the suction surface. This positional change of C in turn induces the blade-to-blade changes in the initial shocks both in strength and direction. Second, the initial difference in the shock direction amplifies the shock-to-shock spacing non-uniformity as the shocks propagate upstream. Therefore seemingly small stagger errors result in substantially irregular shock patterns. Philpot (Ref. 3) appears to be the first to speculate the importance of stagger errors for MPT. The blade contour errors would also be a strong generator of MPT due to their effects similar to stagger angle errors. The control of such errors, however, is extremely difficult to achieve because of the buffing practice in manufacture and deposition of foreign materials during flight service.

4.0 MPT EXPERIMENTS

4.1 Introduction

Previous investigators (Ref. 1, 2 and 3) have studied the growth of the multiple pure tones in full-sized compressors. In most of these cases the flow geometry upstream of the rotor plane was rapidly diverging, i.e. an inlet bellmouth was used. Only a very limited amount of data (Ref. 2) was taken in a constant area annulus. In this investigation, to establish the connection between blade defects and MPT generation, the rotor nonuniformities are measured and used to predict the MPT generation. To allow a reasonably valid comparison between the predictions and experiments a constant area inlet annulus of approximately 9 rotor blade spacings is used. The evolution of the wave pattern in this long inlet is investigated by placing piezoelectric pressure transducers in the outer wall at three upstream locations. Measurements of the noise emanating from the compressor inlet are simulated by using a traversing microphone in an inlet-acoustical plenum chamber. The effect of the length of the inlet duct on this sound emission will be investigated by using two different duct lengths.

The effect of the flow variables that are of interest, the relative Mach number and the inlet flow angle, will also be determined. By running the compressor at three speeds and three different discharge load settings at each speed the effect of these variables on the MPT evolution can be determined.

4.2 Test Compressor

The test rotor is a model of a first state fan rotor from the G.E. TF-39, scaled to a 6 inch O.D. and operated in a closed-compressor acoustic test loop. Freon 12 is used as the working fluid to reduce the running speed at any given Mach number.

The compressor consists of a single stage 40-blade rotor and a 72-blade outlet guide vane. The rotor blade chord length is 0.6 inch. Figure 7 is a photograph of the rotor and Figure 8 shows the typical blade geometry.

The compressor inlet section is made of two sections, a constant area annulus and an inlet bellmouth, as shown in Figure 9. By removing the annular piece the inlet bellmouth can be brought right up to the rotor inlet plane. In this manner the effect of the inlet duct length on the inlet noise emission can be determined.

To study the generation of the MPT's it is necessary to remove all other possible noise sources, if possible. For

these tests the inlet guide vanes, IGV's, were removed and the struts (2 sets of 8 holding the inlet center body) made very small, 0.047" thick, and placed as far upstream of the rotor as practical. This will reduce the disruption of the wave pattern to a minimal amount. Also the noise produced by the rotor intercepting the waves from the struts will be reduced. To reduce any noise due to the viscous wakes from the rotor impinging on the stator and any potential interaction between the rotor and the stator, the stator is placed about 1.3 rotor blade chords downstream of the rotor.

4.3 Experimental Facility

4.3.1 Test Loop

The model compressor fits into a test loop which was designed to determine the acoustic and monitor the aerodynamic performance of a compressor.

The compressor is coupled to a variable speed eddy current clutch electrical drive which can deliver 100 hp at a maximum 22,500 rpm. A running shaft carbon face seal and static elastomer seals isolate the test gas from the external environment. To isolate the plenum chamber and the piping from the compressor vibrations thick rubber gaskets are used as shear-type connections on the inlet and exhaust.

Figure 10 presents a layout drawing of the compressor test loop with the reverberation chamber located upstream of the compressor. The volume of the plenum chamber is approximately 60 cubic feet with a 16.8 sq. ft. cross-section. The inlet duct of the compressor is coupled to the side of the lower portion of the chamber.

The compressor annulus has a 0.092 sq. ft. cross section for an inlet contraction area ratio of 182.6. Following the compressor blade rows, the annular flow path diffuses over an area ratio of about 2.7 and is then collected in an 8 inch diameter duct. The flow on leaving the compressor passes through a ball valve, a heat exchanger, an ASME metering nozzle, and an acoustic muffler before returning to the plenum. A minimum of 30 db of attenuation is effected by the muffler at frequencies above 2 KHz. On entering the plenum the flow is conditioned through a set of diffusing screens followed by a honeycomb straightener.

Weight flow through the compressor is determined by measuring pressure drop across a calibrated flow nozzle in the 8-inch pipe (see Figure 10). At the start of a test, air is evacuated from the system, and then enough Freon added to bring the pressure slightly above atmospheric pressure. To maintain this condition during tests - thus minimizing possible leakage of air into the system - the Freon tank is left connected to the loop, with the valve open slightly. Gas test samples were taken before and after compressor tests, showing the Freon to be at a very high level of purity throughout the test program.

In a previous program (Ref. 4), the sound levels produced by the drive motor and gear box employed to operate the model compressor were measured and found to be well below the levels to be expected from the compressor. Hence, no acoustic isolation was required.

4.3.2 Aerodynamic Instrumentation

For the tests described in this report only overall compressor performances data are taken. In the inlet annulus total temperature, total pressure and static pressure are measured. In the exhaust duct similar measurements are taken. The total temperature is measured with a TC - type 1/8 inch total temperature probe, manufactured by United Sensor and Control. The total pressure is measured using an 1/8 inch Kiel probe. Static pressure is measured with a wall static tap.

In addition to the above measurements, the pressure in the acoustic chamber (wall static tap), the pressure drop across the nozzle (wall static taps), and the gas temperature at the nozzle (bare-wire thermocouple probe) were also recorded. All these pressure measurements were taken with electronic pressure transducers, Pace Model KP-15.

The compressor speed was sensed by an electromagnetic pickup mounted at the coupling and the speed pulses counted by means of an electronic counter. The flow was measured with an ASME long-radius nozzle of five-inch diameter.

The signals obtained from these sensors are fed into a Hewlett Packard Data-Logger and read sequentially into a teletype console for printout and recording on paper tape for subsequent use in performance evaluation computer programs.

4.3.3 Acoustic Instrumentation

Inlet wave patterns are measured with piezoelectric pressure transducers manufactured by Kistler Instruments, Model 601L1. These probes are acceleration compensated and have a sensitivity to acceleration of 0.002 psi/g. The probes are mounted so that the sensitive portion is flush with the outer radius of the inlet annulus. These probes are located at 0.61, 1.76 and 3.01 rotor blade chords ahead of the rotor.

The microphone in the inlet plenum is mounted on a motor-driven traversing mechanism that causes an oscillating motion of the microphone, back and forth across the chamber, on a circular arc in a plane not parallel to any of the chamber walls. The center of this path is along the compressor axis close to its inlet with a distance from the compressor inlet to the microphone of approximately 2 ft.

This motion takes 26 seconds to transverse completely in both directions. The walls of the inlet plenum chamber are hard metal. Hence, with proper calibration and instrumentation it may be used as a reverberation chamber to determine the acoustic power radiated from the compressor inlet. The details of the instrumental and calibration technique have previously been described in reference (3). Briefly, the procedure is to calibrate the chamber using the "integrated tone-burst method" developed by Schroeder (11). During compressor tests, measurements were made by a 1/8 in. Bruel and Kjaer Model 4138 condenser microphone which had previously been calibrated in Freon 12 gas using an electro-static actuator (3).

Signals from these probes are amplified and fed to a 7 channel instrument tape recorder manufactured by the Norelco Corporation. These magnetic tapes are then analyzed in a spectral analyzer, using a 10 Hz bandwidth. This analyzer uses a time averaging scheme to yield time steady frequency spectrums of the signals. The advantage of this analysis technique is that the time average of the signals is presented and not an instantaneous reading. This reduces the data scatter and produces very clear spectrogram, particularly if the signals have a high random noise content.

4.4 Experimental Results

4.4.1 Rotor Imperfections

Figure 8 shows the typical blade geometry of the rotor as specified on the drawings. To obtain a description of the rotor defects, as an input to the analysis described previously, the assembled rotor was measured prior to testing. The chord angle and the blade spacing were measured at the tip. The blade profiles were inspected, but not measured, and were found to be without major perturbations. Figure 11 shows the variation in chord angle and the blade spacing as measured at the tip leading edge. The average chord angle is measured to be 60.1 degrees, this combined with the angle between the chord line and the tangent to the mean camber line at the tip leading edge of 1.6° yields a stagger angle of 61.7°. The major perturbations occur between blades 7 and 8, and between blades 25 and 26. The stagger angle variations are on the order of ± 1 degree while the spacing variation is within ± 0.017 inch. On the full size fans the stagger angle variation is usually $\pm 1/2$ to $\pm 3/4$ degrees. Because centrifugal force is used to fix the blades in the dovetail grooves, in the full size machines, the relative magnitude of the spacing error is difficult to estimate. However the stagger angle error is the most critical, and it is expected that due to the large variations in stagger angle the MPT content will be very large when compared to full size results.

4.4.2 Aerodynamic Performance

In order to establish the velocity diagrams of this blading, a series of speed lines are run. Figure 12 illustrates the performance data for the conditions as used in the acoustic testing, where P_{T1} and P_{T5} are the isentropic inlet and exhaust total pressures, W the compressor weight flow, θ the inlet temperature correction and δ the inlet pressure correction using 518.6°R and 2116 lb/ft² as a base respectively. A more extensive series of tests were conducted, but are not pertinent to this study. From the performance data, the relative tip Mach number and the incidence angle, can be found from the axial flow velocity, the rotor tip speed and the blade stagger angle. Figure 13 shows the variation of incidence angle, α , with the relative Mach number, M_r , for three different speeds and three different discharge valve settings. The variation of incidence angle is less over the speed range than the load range, with a maximum variation of 2 degrees from 19,000 rpm to 22,700 rpm, while a maximum variation of 3.5 degrees occurs when changing from the least discharge resistance to near stall. The relative Mach change with discharge setting is quite small, (for a fixed speed) about 3% or less.

4.4.3 Acoustic Tests

4.4.3.1 Microphone Calibration

In condensor microphones the motion of the diaphragm depends on the dynamic and dissipative affects of the ambient. Since the microphone used in this study is designed for use in air, a calibration of the frequency response characteristics in the Freon 12 environment is conducted. In this test the microphone and electrostatic actuator are placed in a small glass-walled test chamber. The chamber is evacuated and filled with Freon 12, and held at a slightly elevated pressure, 2 to 5 psig. The electrostatic actuator is driven through a Bruel and Kjaer microphone calibration apparatus, #4142, and the microphone, a Bruel and Kjaer 1/8 inch, #4138 is powered by a Bruel and Kjaer Power Supply, #2801. Figure 14 shows the response relative to the low frequency (250 Hz) calibration conducted in air using a Bruel and Kjaer piston-phone. Since the frequency range of interest was less than 16 KHz, only a portion of the dynamic range of the microphone was investigated. For the ambient pressure range (0 to 3 psig) used, the effect on microphone sensitivity was negligible, in the frequency range of interest (250 Hz to 50 KHz).

4.4.3.2 Acoustic Data Reduction Methods

The principal method of data reduction employed in this report is to tape record the acoustic signals and then use a spectral analyzer to obtain the amplitude frequency spectrum of the signals. An important feature of the particular system employed is a technique for obtaining the time average of the spectrum. The analog signals are sampled, digitized and stored in a digital computer and then the average computed from these (100 to 200) samples. This average value is then converted back to an analog form to drive the cathode ray tube, CRT, display. For the data obtained on this study the averaging time was varied from 2 to 4 seconds and the results were found to be very time steady. To illustrate, in a run of 40 seconds in duration there would be 10 frequency spectra produced (for a 4 second averaging time) and these spectra would be nearly identical.

The primary advantage of this technique is in reducing the data scatter, particularly for broadband noise, since at any frequency it provides the time averaged value of the signal amplitude. The CRT display is then photographed using a special 35 mm camera. Figure 15 shows the CRT display amplitude versus the relative db level of the signal on the tape. There are three separate runs on this figure and to obtain quantitative measurements from the spectral displays the db difference from the calibration signals must be used. If a calibration signal produces an amplitude of 25/60 inches

at a SPL = 160 and the signal of interest has an amplitude of 20/60 inches then the signal SPL level is 160 - (53.4 - 46.6) or 153.2 db (for data reduction run (1)).

4.4.3.3 Blade Passing Frequency Results - Long Inlet Duct

There are four parameters of interest in this investigation; (1) upstream distance from rotor inlet plane, x , which is normalized by the rotor chord length, C , (2) relative inlet Mach number at the rotor tip, M_r , (3) incidence angle of the flow, α , and (4) compressor speed, N = (rpm), or expressed as blade passing frequency, BPF. Mach number and the incidence angle vary simultaneously as the flow through the compressor is changed by the discharge valve. Figures 16, 17 and 18 show the variation of the SPL (contained in a 10 Hz bandwidth around BPF) with upstream axial distance from the rotor. On each figure three different discharge valve settings are given for each compressor speed. In all the cases except one, the BPF noise exhibits a rapid drop-off with increasing axial distance. This unexpected rise, (see Fig. 16) of the BPF content with axial distance appears to be due to the increased broadband noise at that particular position and conditions, ($x/c = 3.01$, BPF = 13 kc and the intermediate flow setting) when compared to the other axial positions. Close to the rotor ($x/c = 0.61$) the BPF noise decay with distance is very rapid ranging from 21 db/chord at high compressor speed to about 33 db/chord at the low compressor speed. When the compressor flow is reduced the BPF noise increases for all the compressor speeds, neglecting the slight dip at the $x/c = 3.01$ station when running at the highest speed.

The changes in BPF noise with the flow reductions are very large for the low speed (13 - 13.25 kc) runs and the high speed (15.1 kc) runs while for the intermediate speed (14 kc) runs they are much smaller. One would expect the BPF content to be increased due to increase in the incidence angle as this will increase the separation of the unattached shock (at these high angles) and delay the MPT noise generation. These changes, however, are much too large to be totally accounted for by the upstream motion of the bow shock wave due to this increase in incidence angle.

Since both the relative Mach number and the incidence angle are varying together, the two effects are somewhat confounded, to alleviate this situation the same data is redrawn on Figures 19, 20 and 21 as a function of the relative Mach number, with the incidence angle as a parameter, for the three axial transducer locations. Close to the rotor ($x/c = 0.61$) the BPF content decreases with increasing M_r and increases with increasing α . The variation with Mach number is expected since the higher Mach number would be expected to have a faster decay of the BPF content due to faster development

of the "skewed" wave patterns. The effect of increasing the incidence angle is apparently causing an increase in overall SPL close to the rotor, as well as a shift in shock position as mentioned before.

At $x/c = 1.76$ raising the incidence angle at a fixed Mach number causes very little change until close to stall, when a rise in the BPF content occurs. This increase in BPF noise does not appear to be due to an increase in the broadband noise level.

At $x/c = 3.01$, raising the incidence angle at high Mach numbers causes the BPF content to decrease and then rise. For this position raising the Mach number causes the BPF content to decrease. This dropping phenomenon is associated with the decay of the BPF content and the strength at the rotor inlet plane since it did show up at $x/c = 0.61$. The overall trends observed are that BPF noise decreases with increasing M_r and increases with increasing α .

Oscilloscope photos of the wall static pressure wave forms are shown on Figures 22 and 23. The effect of compressor speed, principally Mach number is shown on Figure 22, the flow conditions are similar to the high flow conditions (wide open discharge valve) as shown on Figure 13. The top trace is from a 40 tooth gear mounted on the compressor drive shaft with a notched tooth positioned such that it passes the magnetic pickup when the blade number 1 is passing the tangential position of the pressure transducers. The position of the major perturbations of the wave form (from a uniform wave at BPF) are closely correlated to the position of the major imperfections of the rotor as described in section 4.4.1. These wave forms would be representative of the (wide open discharge valve) data as shown on Figures 19, 20 and 21. The decrease of the BPF content with distance and Mach number is clearly evident from this figure. Also the signals are seen to be "locked to the rotor" and spiralling up the inlet duct. The effect of throttling the compressor at a fixed speed is shown on Figure 23. Again the conditions are similar to those on Figure 18.

4.4.3.4 Multiple Pure Tone Distribution - Long Inlet Duct

Figures 24 through 32 show the SPL spectrum for the three transducers located in the inlet duct as well as for the plenum microphone. From these figures it can be seen that the spectra are very rich in MPT content. In particular, even close to the rotor (at $x/c = 0.61$) the MPT content is quite large, and in some cases the predominant MPT's are greater than the BPF noise. On the left side of each spectra are the calibration signal level, the deflection that signal would have and the calibration curve to use on Figure 15 (as

explained in section 4.4.3.2), these values are used to obtain quantitative measurements of the spectra.

The distribution of these tones is fairly uniform, so that by measuring the maximum peak in the frequency range from 3 to 10 KHz a fairly good idea of the MPT content is obtained. Table 4 shows the SPL at the BPF, at the mid-range and at the low frequency end of the spectrum for all the nine runs. On Figures 33 through 35 the SPL of the peak MPT in the mid-band of the spectrum (3 to 10 KHz) is shown. In general the MPT strength decreases in the upstream direction but not as fast as the BPF noise, and the rate of decrease slows with increasing Mach number. Apparently due to the large nonuniformities of the rotor the prominent MPT's are established very quickly and decay slowly in the upstream direction. This decay of the prominent MPT's is predicted by the results of the analysis. The axial decay of the MPT's are in apparent contradiction with previous reported results. The reasons for this difference appear to be due to two effects: (1) the level of the MPT's at the first measuring point ($x/c = 0.61$) are large in this study indicating that the nonuniformities are larger than used previously. This will cause an early establishment of the predominant MPT's. With smaller nonuniformities a larger axial distance is required before the MPT's develop significantly. (2) The previous results indicate that the level of the MPT's reach a plateau and then travel upstream unchanged. These results, however, are based on measurements taken in an inlet bellmouth, which may alter the MPT evolution process with respect to what occurs in a constant area annulus.

At the lowest speeds, reducing the fan weight flow with the discharge valve reduced the MPT level. This trend changes as compressor speed increases and at the highest speed reducing the through flow causes an increase in the MPT level. Varying the compressor speed at a fixed discharge setting causes the MPT noise to have a maximum near a relative Mach number of 1.15. When compared to the BPF noise, Table 4, the dominance of the mid-range MPT's over the BPF noise is a monotonically increasing function with axial distance for the higher speed runs ($BPF \geq 14$ KHz), and shows a rising and then a falling dominance for the lowest speed run. This is due to the more rapid decrease of the MPT's with distance for this compressor speed ($BPF = 13$ KHz).

4.4.3.5 Plenum Measurements

The SPL frequency spectra as measured in the inlet reverberant chamber (plenum) are shown on Figures 24 through 32 for the long inlet duct case. The BPF drops rapidly with relative Mach number as can be seen on Figure 36. The long inlet data has not been corrected for the frequency response of the microphone, this will reduce the SPL at BPF by 6.5 db. The

plenum BPF noise is much less sensitive to the incidence angle when compared to the wall static measurements in the inlet duct. This can be seen by comparing Figure 36 to Figure 21 (for the long inlet case), the plenum measurements can be plotted on a single line. Overall trends are quite comparable, though, having an initial rapid decrease with M_r and then a leveling off.

By removing inlet annulus and keeping everything else the same, the effect of inlet duct length on the sound emission is investigated. On Figure 36 the SPL at BPF with the short inlet is shown, along with the case for the long inlet. The level of the BPF noise for both of the plenum measurements are much lower than the wall statics, as is expected. The short inlet case is about 16 db higher in SPL (remembering to correct the long inlet data) with nearly the same decay with relative Mach number. For this short inlet case, to correlate the near field to the sound emission, a rough comparison can be made between Figure 19 ($x/c = 0.61$) and Figure 36. Again the effect of incidence angle is much less in the plenum measurements and the trend of the decay of the SPL at BPF is comparable for both cases.

Figures 37, 38 and 39 show the plenum SPL frequency spectra for the short inlet runs. Table 5 shows the plenum SPL of the rotor frequency (RF) noise, the level of the prominent MPT in the mid-range of frequency (3 to 10 KHz) and the blade passing frequency noise. These data are all taken at a fixed microphone position and may not be representative of the overall emitted sound due to the variation of the signal with position, as can be seen by referring to Figure 36. Therefore an error of approximately 4 db is possible in these measurements. Overall the MPT's of the short inlet are more uniformly distributed than for the long inlet case. The largest difference in the comparable spectra of the long and the short inlet occurs at frequencies above the rotor frequency. The long inlet results have much lower level mid-range MPT's (particularly at the lowest compressor speeds) than the short inlet case. The MPT's of the long inlet duct, become concentrated at the low frequency and the high frequency end of the spectrum when the compressor weight flow is reduced at constant speed. This concentration of MPT's at the low frequency end (in the long inlet case), is particularly evident for the highest speed runs (BPF = 15 KHz).

The variation of the plenum RF noise with compressor speed, along a fixed load line, is quite different for the two inlet cases. In the case of the long inlet, at the maximum flow setting, the RF noise increases steadily, but at the intermediate and the near-stall setting it rises, then drops with increases of compressor speed. This rising and dropping also occurred in the predominant MPT's of the wall static

measurements, at $x/c = 3.01$. With the short inlet, the maximum flow setting produces a rising and falling RF noise variation with increasing compressor speed, while more restrictive settings continually increase, just the reverse of the long inlet case.

The position of the plenum microphone is the same for the SPL spectra appearing on Figures 24 through 32, 37, 38 and 39 and on Table 5. The variation in SPL as the microphone sweeps across the plenum chamber can be seen by referring to Figure 36.

4.4.4 Experimental Summary

4.4.4.1 Long Inlet Duct

The BPF noise, in general, decreases rapidly with upstream axial distance from the rotor, decreases with relative Mach number of the rotor and increases with the flow incidence angle.

The level of the dominant MPT, also decreased in the upstream direction but not as rapidly as the BPF noise and less rapidly as compressor speed is raised. Comparing the MPT noise to the BPF noise yields a monotonically increasing dominance with distance of the MPT noise over the BPF noise for the cases of the higher speed runs ($BPF > 14.0$ KHz). At a fixed discharge setting the MPT noise increases with compressor speed until the relative Mach number is about 1.15 and then it decreases. At a fixed compressor speed the variation of the MPT with flow reductions ranged from decreasing the MPT level (at the lowest speed) to increasing the MPT level at the intermediate and highest speeds.

The angular position of the major disturbances to the pressure wave forms spiralling up the inlet duct are well correlated to the major nonuniformities of the rotor geometry.

4.4.4.2 Short Versus Long Inlet Duct

By changing the long inlet annulus (4.125" in length) and starting the inlet bellmouth nearly at the rotor inlet plane a 16 db increase in BPF noise level is obtained. With either inlet the plenum BPF noise falls off rapidly with relative Mach number, until about $M_r = 1.2$. The incidence angle variations are seen to have a much smaller effect on the plenum BPF noise than on the inlet duct wall static BPF noise.

The correlation of the measurements made in the inlet duct to the emitted sound are also of interest in this study. By comparing $x/c = 3.01$ wall static measurements to the plenum (long inlet) results a qualitative measure of this can be

obtained. In all cases the noise at the rotor frequency dominates the plenum measurements, with the BPF noise showing up only at the lowest speed runs. The BPF noise is much lower within the plenum but has about the same rate of decay with M_r as at $x/c = 3.01$. A reduction of the MPT's above the 20th multiple of the rotor frequency is another major difference in the spectrum between the $x/c = 3.01$ location and the corresponding plenum measurements.

To compare the short inlet measurements in the plenum to the wall statics, the position, $x/c = 0.61$, can be used as representing the events close to the rotor. Again the BPF noise is lower in the plenum, but has a comparable rate of decay with Mach number. The rotor frequency noise again dominates the plenum measurements, in contrast to the wall static results at $x/c = 0.61$. The mid-range MPT's are suppressed but not as much as the case with the long inlet.

The overall effect of having a short inlet appears to be:

- (1) a large increase in BPF noise,
- (2) an increase in the mid-range MPT's, resulting in a more uniform spectral distribution of the MPT's,
- (3) an increase in RF noise, that is almost negligible at the lowest speeds and increases with compressor speed.

4.4.5 Comparison Between Theory and Experiments

Only the effects of stagger angle errors and blade spacing errors are included in the calculations. The limited size of the model fan impeded any precise measurements of the blade contour errors. Thus this effect, which could have potentially significant bearing on MPT, is not included in the computed results.

In the analysis, it was assumed that shocks are attached at the leading edge. However in the model fan, the leading edges of the blades are quite blunt and the shock is probably detached. The detached shocks introduce two modifications. First, the standoff distance displaces the origin of the shock slightly ahead of the leading edges. The displacement effects themselves have no bearing on the MPT but the blade-to-blade variations of standoff distance could modify the MPT evolution. Such standoff distance variations would, however, be effectively the same as the blade spacing variations and this might not have appreciable effects on the MPT generation. Second the appearance of a subsonic region downstream of the detached shock delays the incipience of shock expansion fan interference. Therefore at a given axial distance upstream of rotor, the amount of shock expansion

fan interaction would become less and MPT evolution might be reduced. In any event, since the computer programming was written for the attached shock, the effects of detached shock could not be taken into account. Instead an ad hoc improvisation was made in the following way to handle blunt leading edges. The model blade contour on the suction surface is not unlike a wedge, but near the leading edge it is joined into a small circle. In the computation, it is assumed that the attached shocks start at the transition point between the wedge and the circle.

Since this ad hoc assumption breaks down for low Mach number, the computation will be limited to the case of higher Mach number. A relative Mach number of 1.25 is used. As for the angle of attack, the restriction that the shocks should be attached at the transition point put some light on the choice of angle of attack. Here the angle of attack is chosen to be 1.8 degrees, somewhat less than the values at which the experiments were conducted. These input data were tabulated in Table 6. In Fig. 18, where the decay of the sound pressure level centered at the blade passing frequency is shown, the computed value is compared with the experimental results. The agreement is fairly good considering the various assumptions made in the analysis and particularly the fact that blade contour nonuniformity, a possibly important factor, is not used in the computation. The computed evolution of the MPT is plotted in Fig. 40. In this figure, positions K-1, K-2 and K-3 correspond to the positions of the probes located at $x/c = 0.61$, $x/c = 1.76$ and $x/c = 3.01$, respectively. When one compares this with the measured results, Figs. 30, 31 and 32, it is noticed that in the computed results there are virtually no MPT's between tenth harmonic and thirtieth harmonic, whereas in the experimental results there are many MPT's in between. The main reason for this difference is considered to be due to the blade contour nonuniformity, the effect of which, as repeatedly mentioned, is not included in the computed results. However the computed results do predict that the largest MPT is the first harmonic of the shaft frequency, which agrees with the experimental results.

5.0 CONCLUSIONS AND RECOMMENDATIONS

A theoretical and experimental investigation was conducted on multiple pure tone noise. Multiple pure tone sound from aircraft engines is characterized by a noise spectrum containing numerous spikes at integer multiples of the shaft rotational frequency.

In the analysis, it is assumed that the flow is two-dimensional and inviscid and the bow shocks emanating from the blades are attached to the leading edges. The analysis, consisting of the construction of shock expansion wave diagram, predicts the generation and evolution of MPT from the prescribed blade-to-blade nonuniformities in rotor geometry. The results show that even small nonuniformities, within the manufacturing tolerances, can cause a significant amount of multiple pure tone noise. The trend of the computed MPT evolution agrees with a previously observed one. Among different kinds of nonuniformities investigated, errors in blade stagger or blade contours are much stronger generators of MPT noise than errors in blade spacings.

The experimental results concur with the axial decay of BPF noise measured by previous investigators. Other aspects of these experiments have explored the effects of relative Mach number, incidence angle and inlet duct length on the BPF and MPT noise evolution. The results are discussed in section 4.4.4, Experimental Summary.

In order to compare the experimental results with the analysis, the MPT distributions were computed from the measured blade nonuniformities of the model fan. Due to the lack of measurements of the blade contour nonuniformity, an important MPT generator, the comparison between theoretical and experimental results is not exact. However, the computed result correctly predicts the position of the maximum peak of multiple pure tones in the frequency spectrum. The computed decay rate with axial distance of sound at blade passing frequency compares favorably with the measured results, as well as the level of the BPF noise. The angular position of the major disturbances to the pressure waveforms spiralling up the inlet duct are well correlated to the major nonuniformities of the rotor geometry as is predicted by the analysis.

In summary this study has conducted a combined analytical and experimental program that has demonstrated (1) the MPT sound is due to rotor geometry imperfections, and the angular position of the pressure waveform distortions are correlated to the location of these imperfections, (2) the evolution of the MPT sound can be predicted by a two-dimensional, inviscid analysis using the known rotor nonuniformities, (3) rotor relative Mach number and incidence angle are important

parameters to the evolution of the MPT sound in the Mach number range tested, (4) the inlet duct length has an important influence on the MPT sound emission.

As a logical next step for possible future effort in the prediction of MPT sound, the following extensions are recommended;

- (1) In the analysis, to include the effects of detached bow shocks.
- (2) In the experiments, to measure the blade contour nonuniformities.
- (3) Extend the Mach number range.

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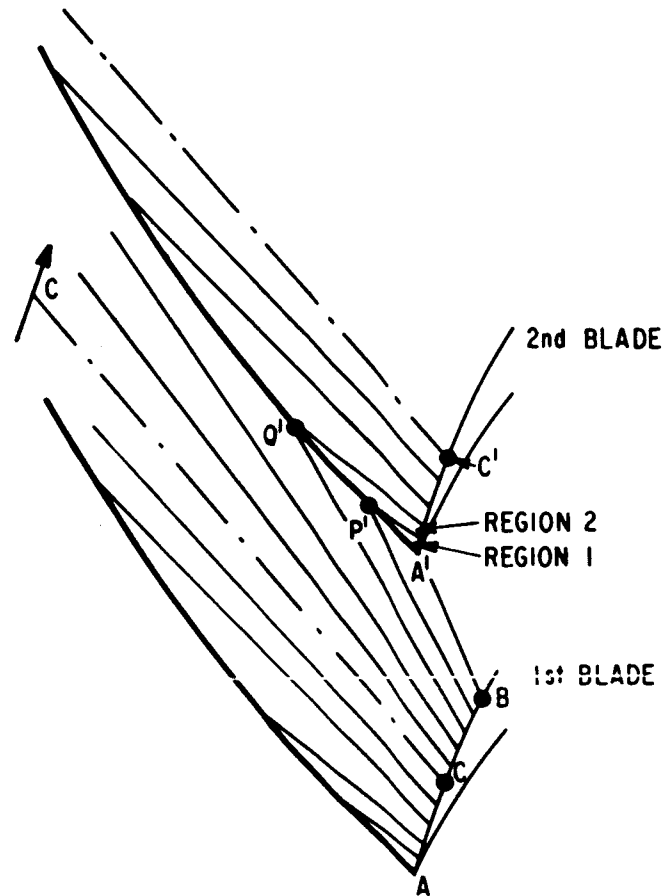


Figure 1. Wave Systems for Idealized Uniform-Bladed Rotor.

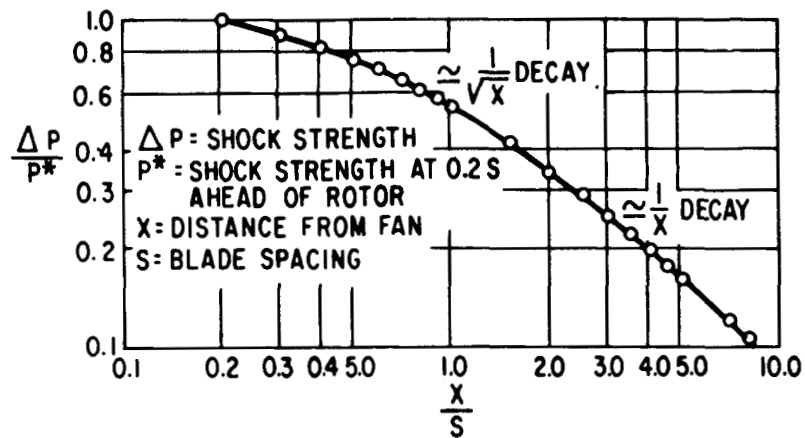


Figure 2. Computed Decay of Shock Strength for an Ideal Uniform Rotor.

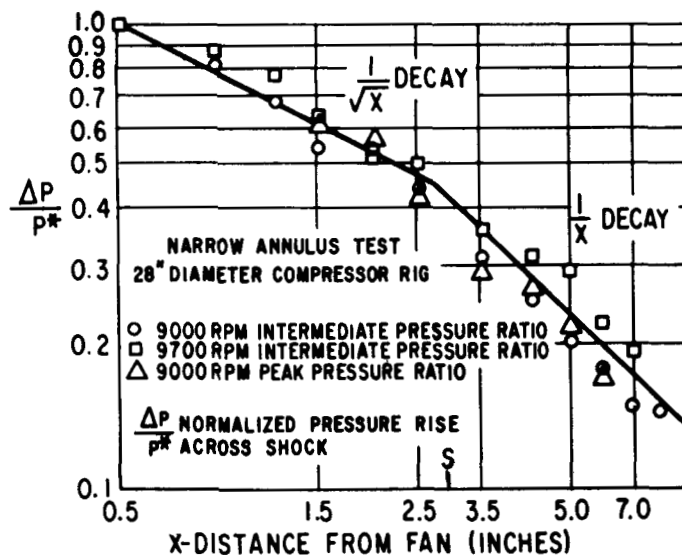


Figure 3. Measured Decay of Shock Strength (Figure 14 of Ref. 2).

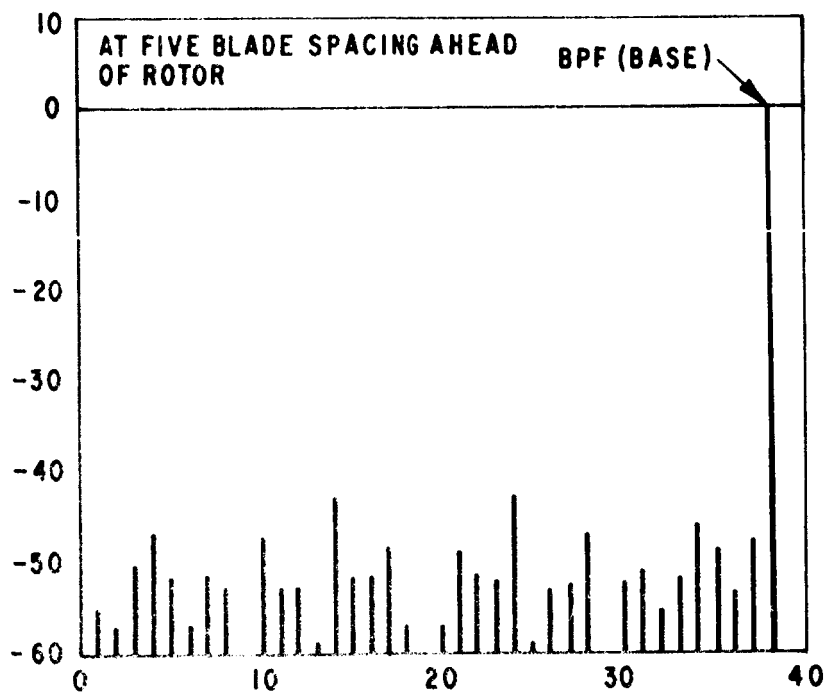
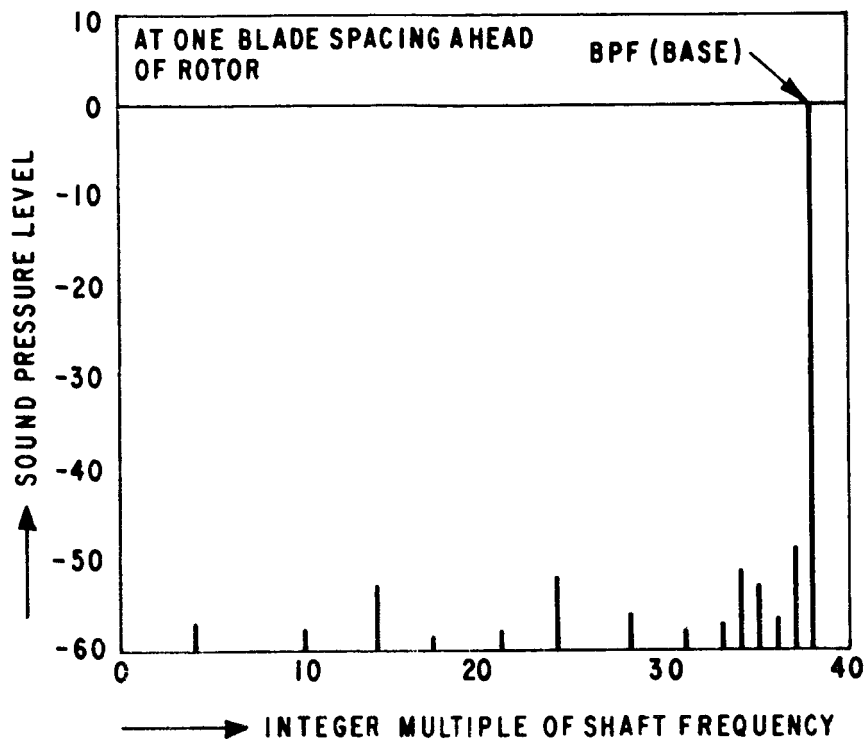


Figure 4(a). Effect of Blade Spacing Errors
(Error Distribution, A-1 of Table 2).

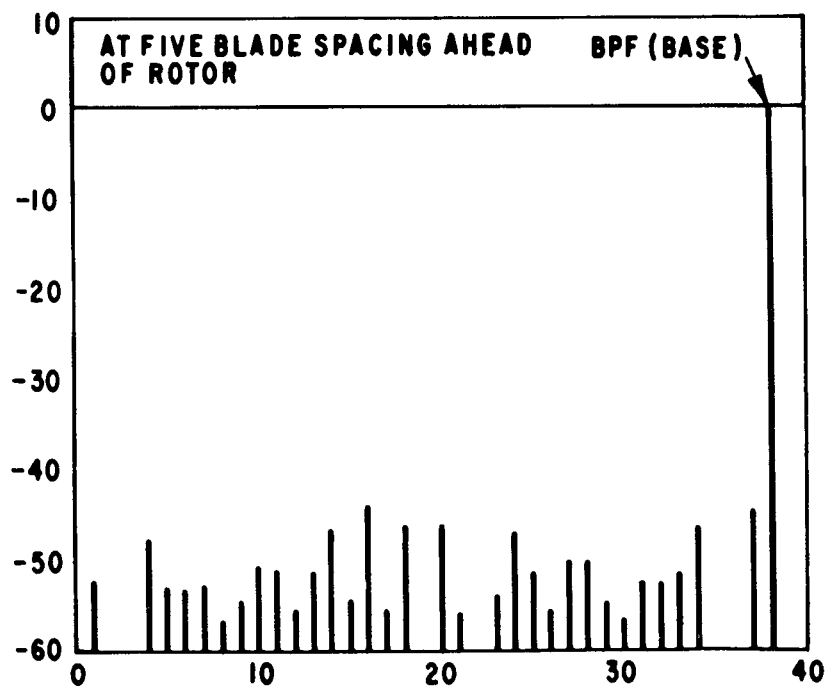
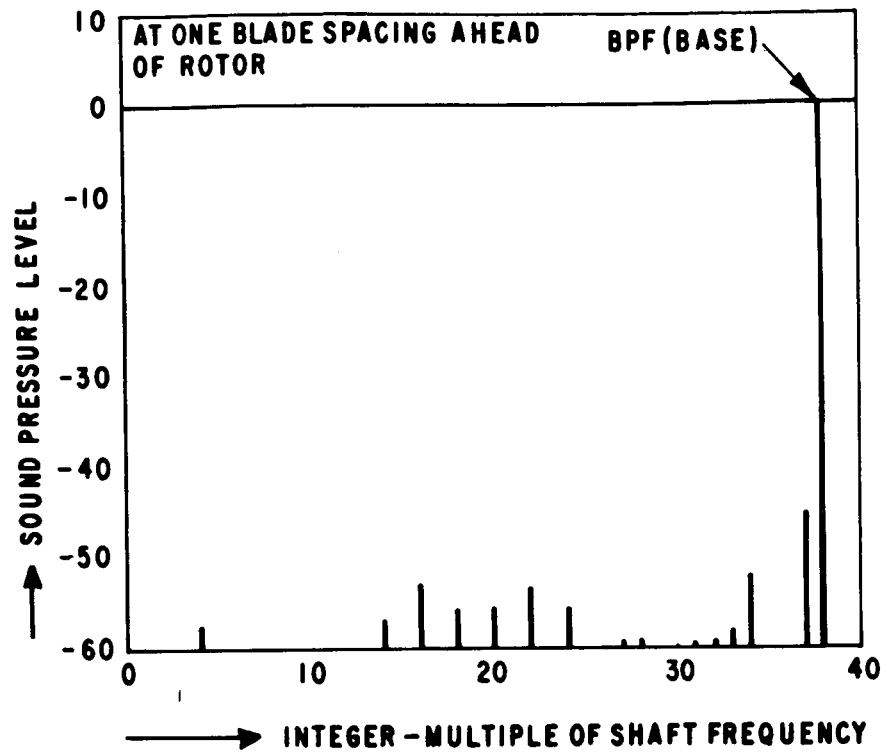


Figure 4(b). Effect of Blade Spacing Errors
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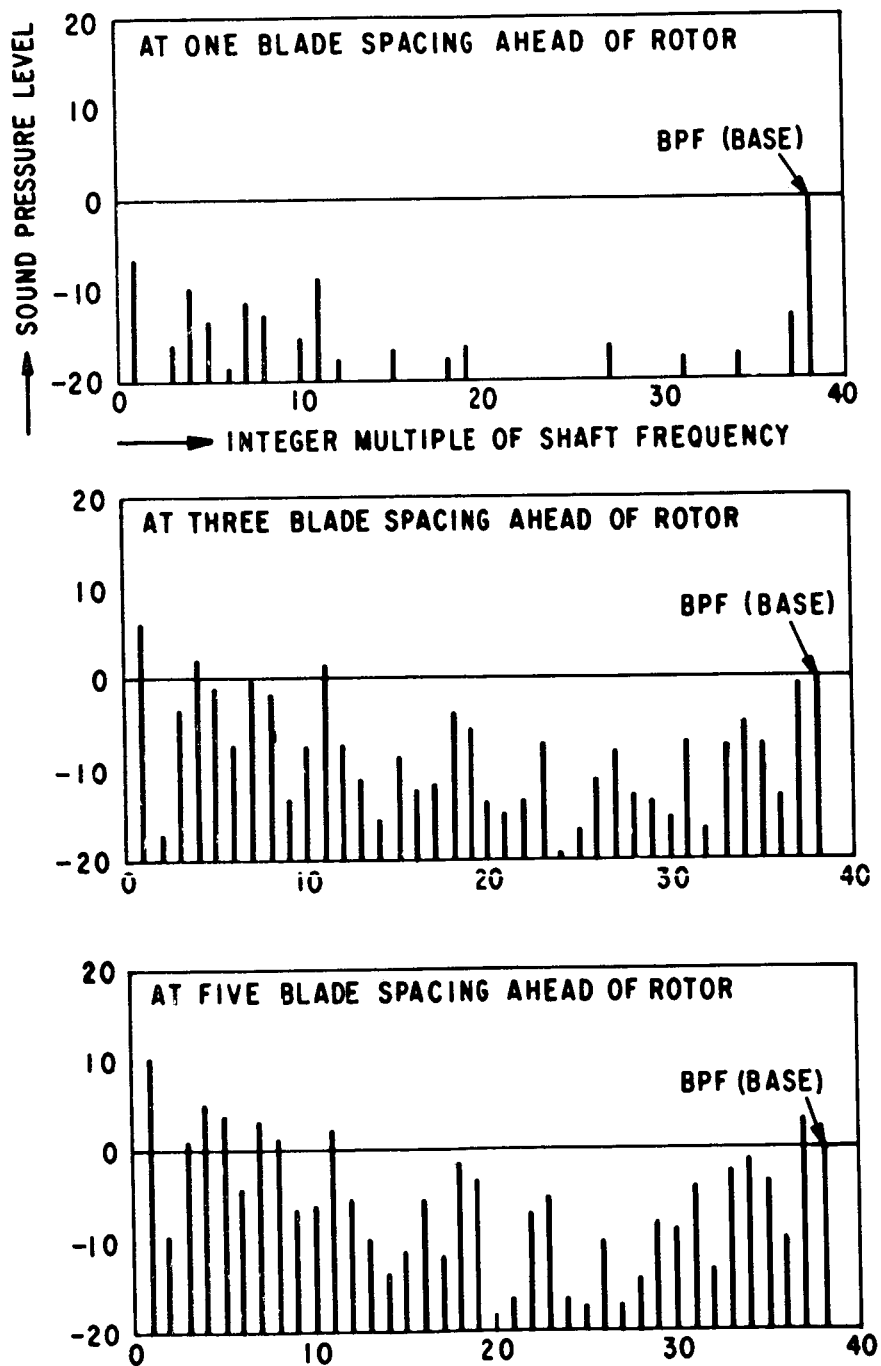


Figure 5(a). Effect of Stagger Errors
(Error Distribution, B-1 of Table 3).

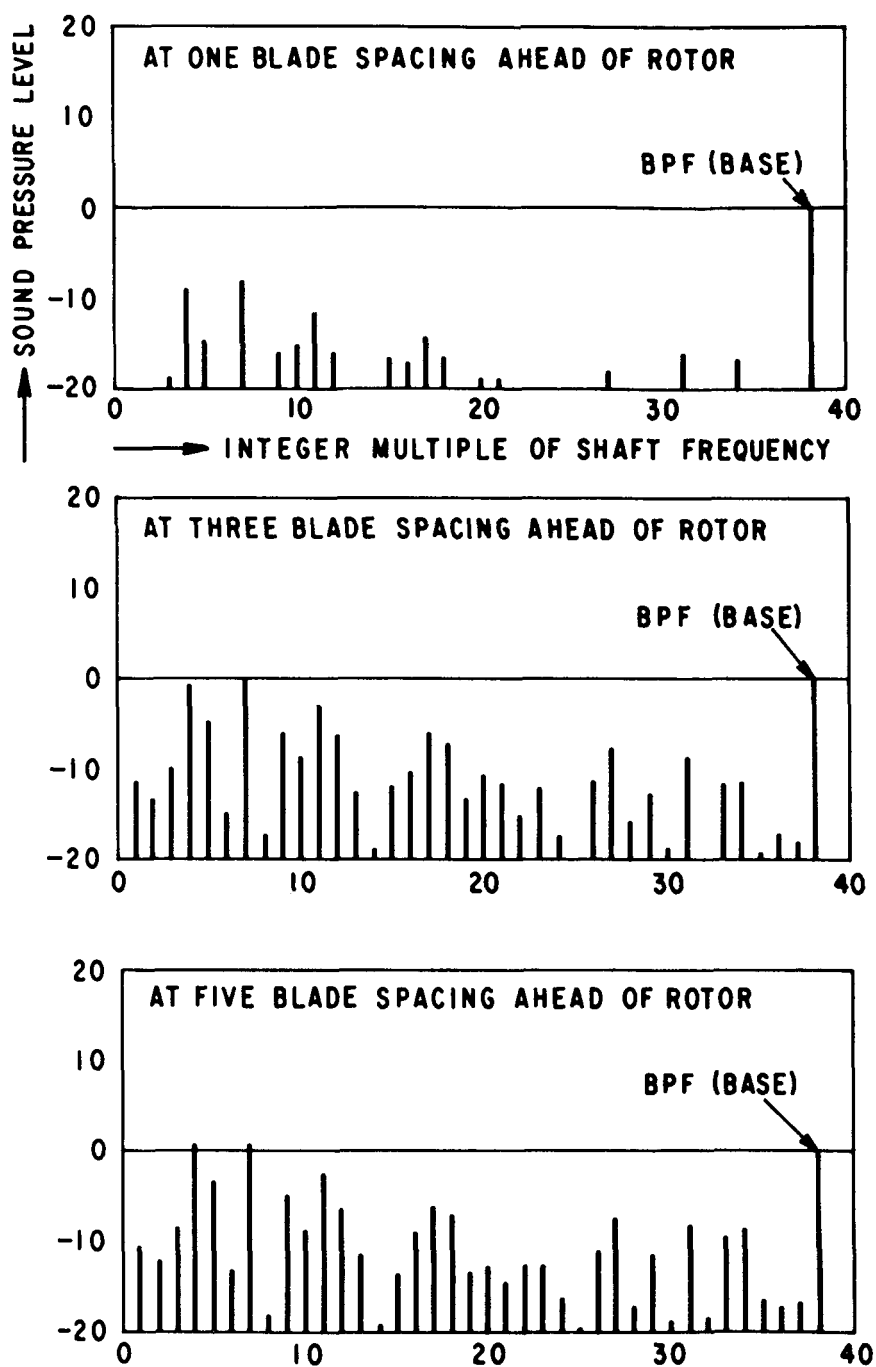
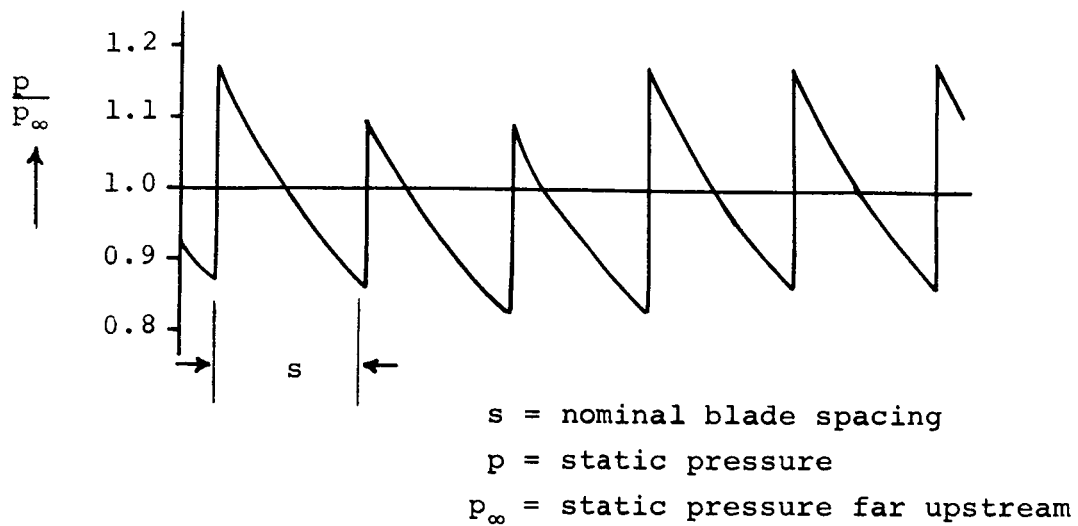


Figure 5(b). Effect of Stagger Errors
(Error Distribution, B-2 of Table 3).

At 0.1 Blade Spacing Ahead of Rotor



at 5 Blade Spacing Ahead of Rotor

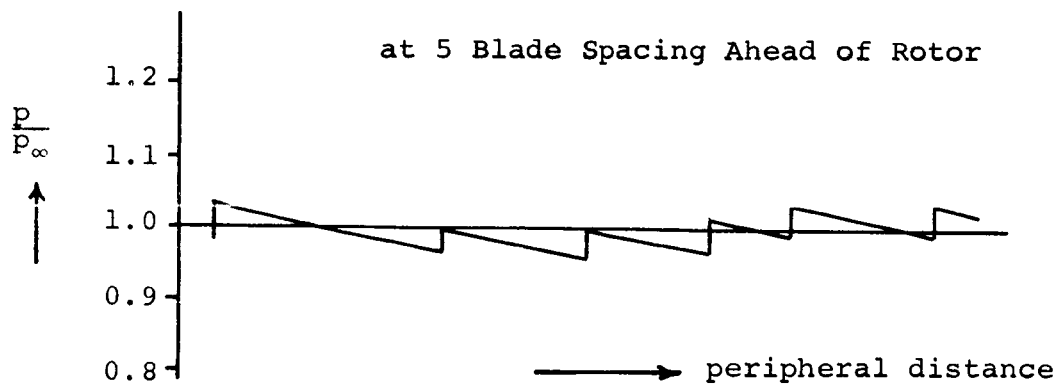


Figure 6. Change of Pressure Profiles.

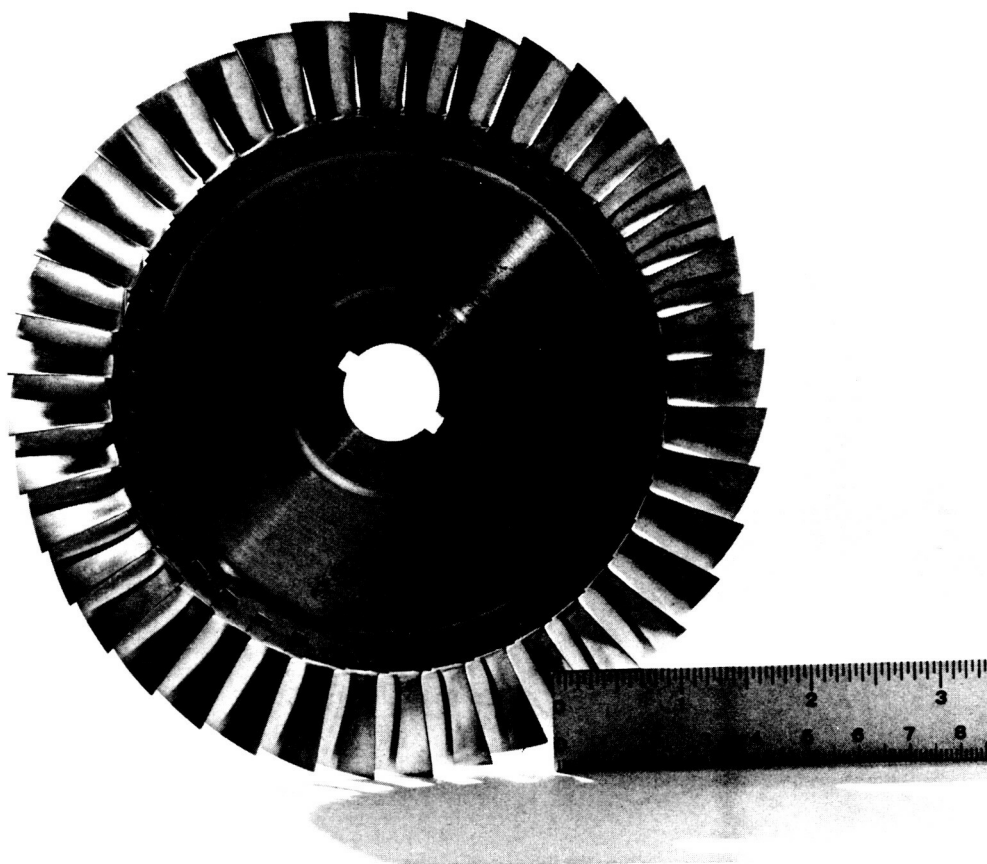
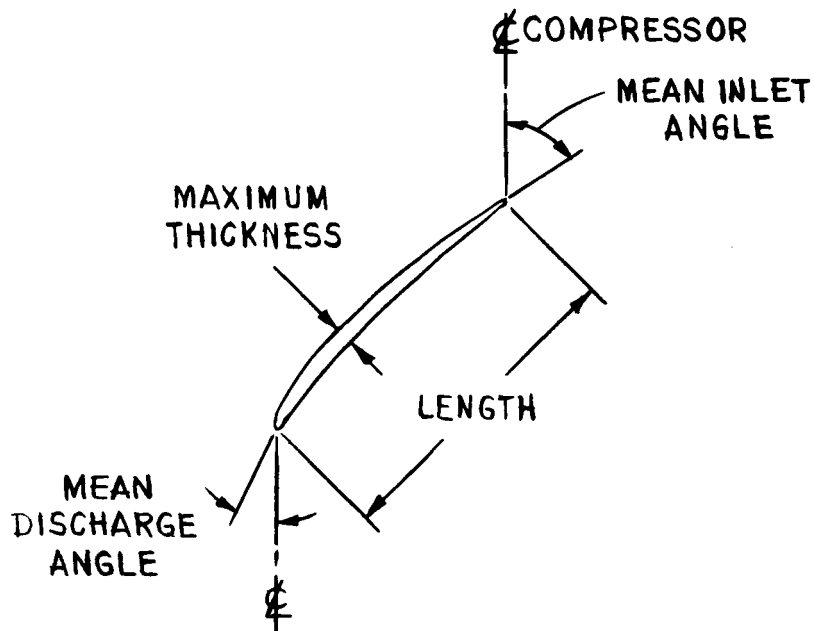


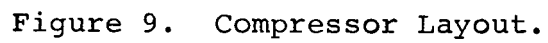
Figure 7. Scale Model Rotor.

MODEL COMPRESSOR ROTOR (40 BLADES)



	<u>TIP</u>	<u>PITCH</u>	<u>HUB</u>
RADIUS (IN.)	2.957	2.549	2.196
MAX. THICKNESS (IN.)	0.014	0.020	0.022
LENGTH (IN.)	0.591	0.520	0.445
MEAN INLET ANGLE	63° 54'	56° 43'	55° 56'
MEAN DISCH. ANGLE	57° 14'	48° 33'	40° 26'

Figure 8. Rotor Blade Geometry.



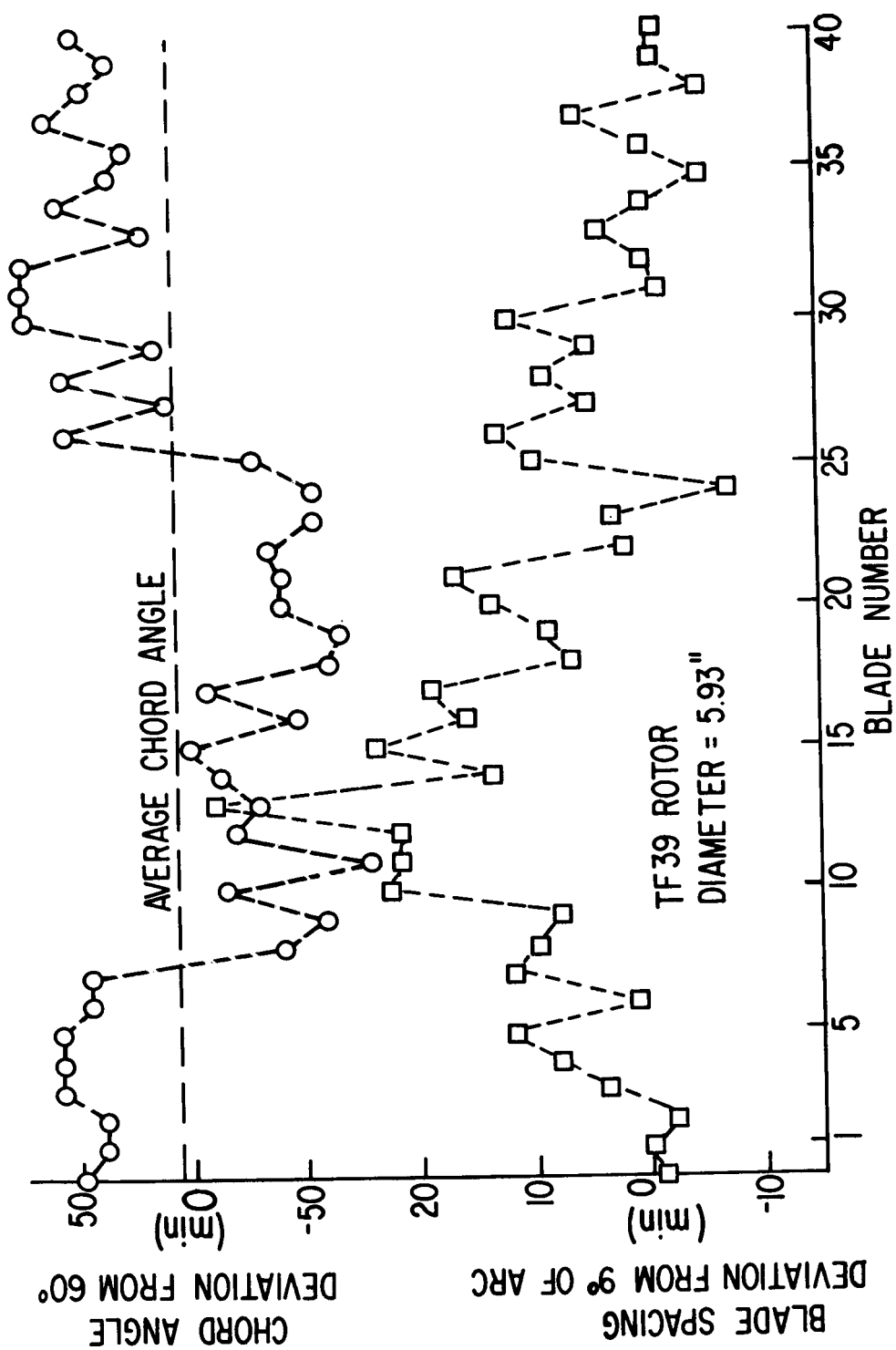


Figure 11. Rotor Nonuniformities.

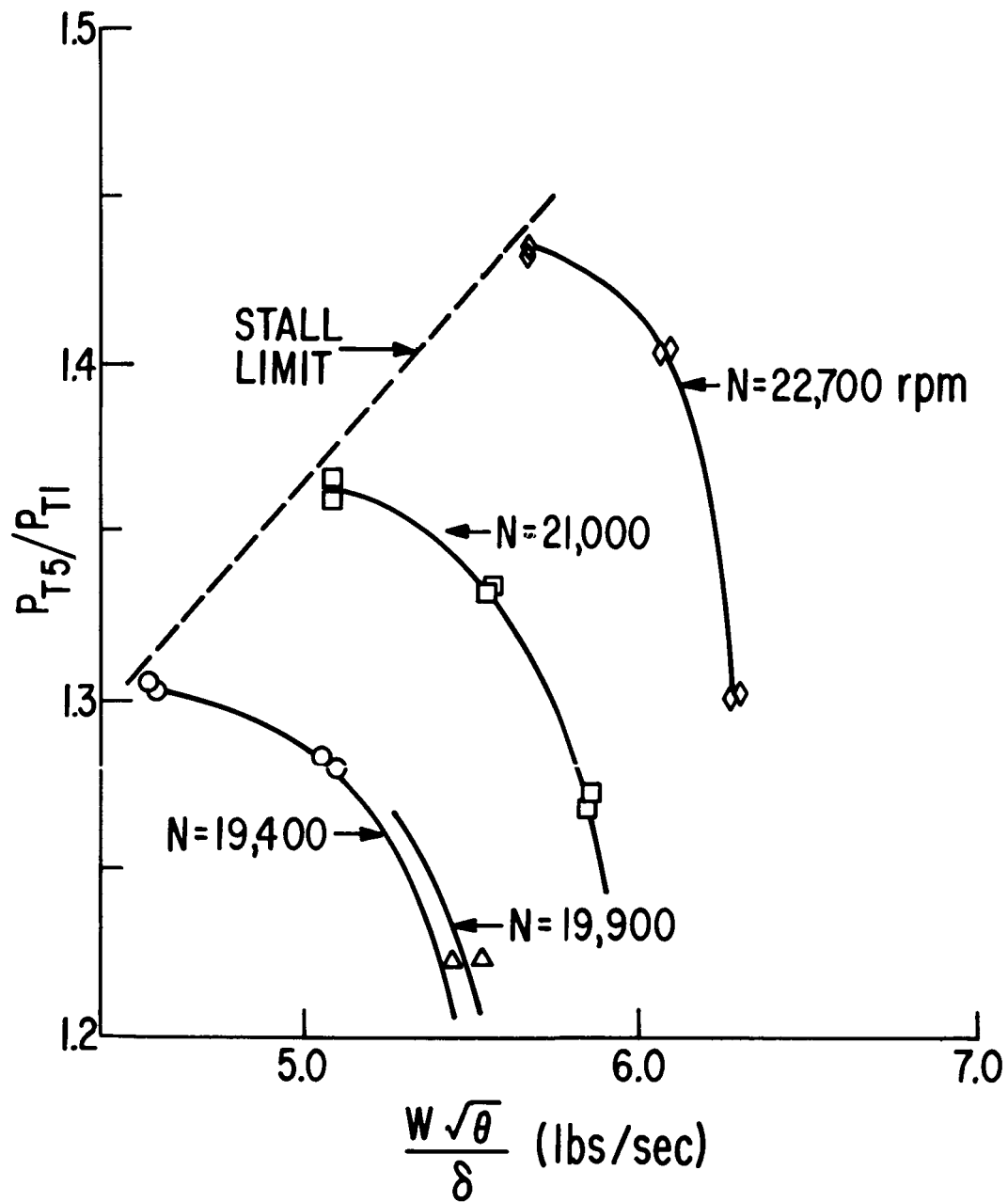


Figure 12. Model Compressor Performance Map.

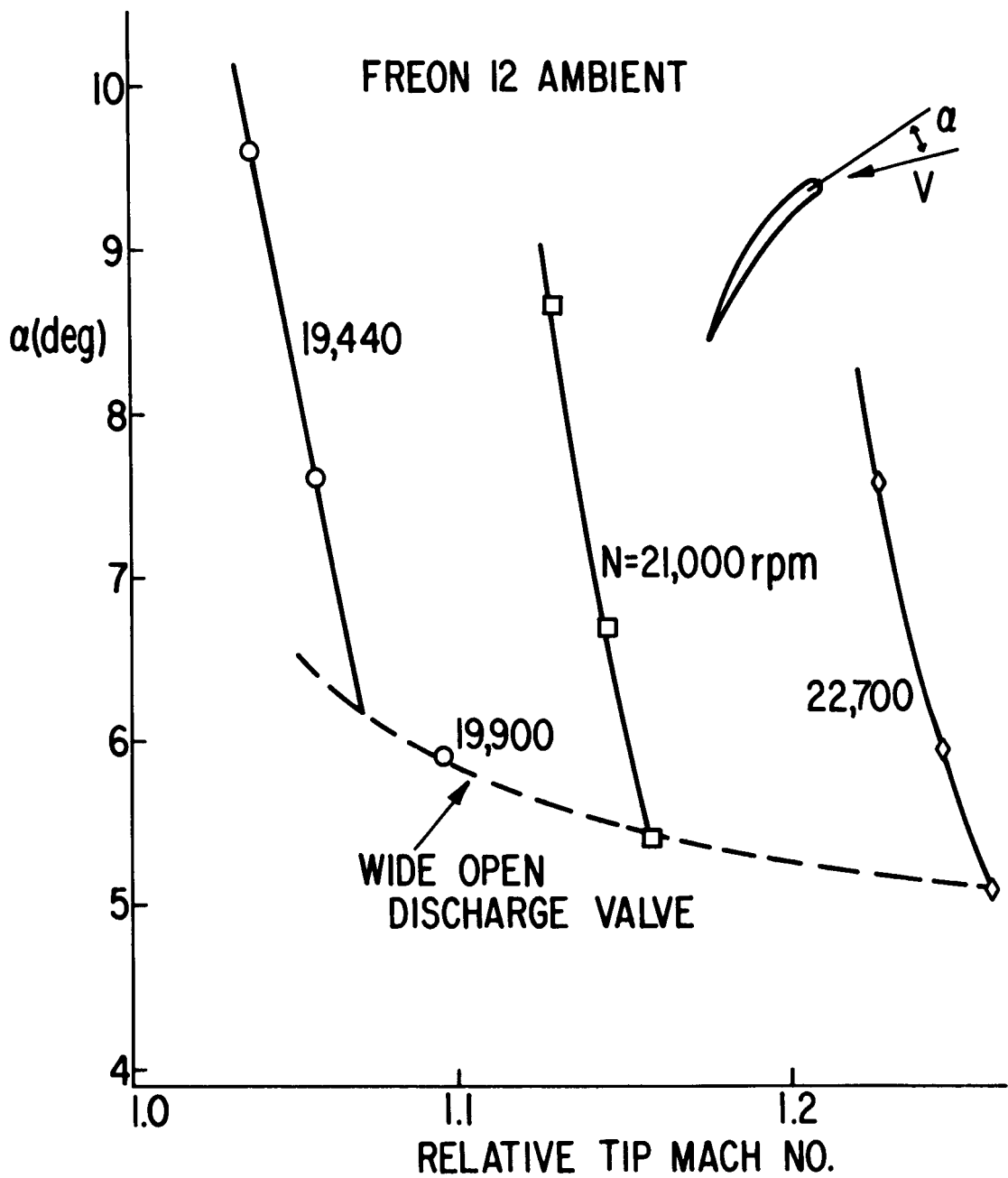


Figure 13. Incidence Angle Versus Mach Number.

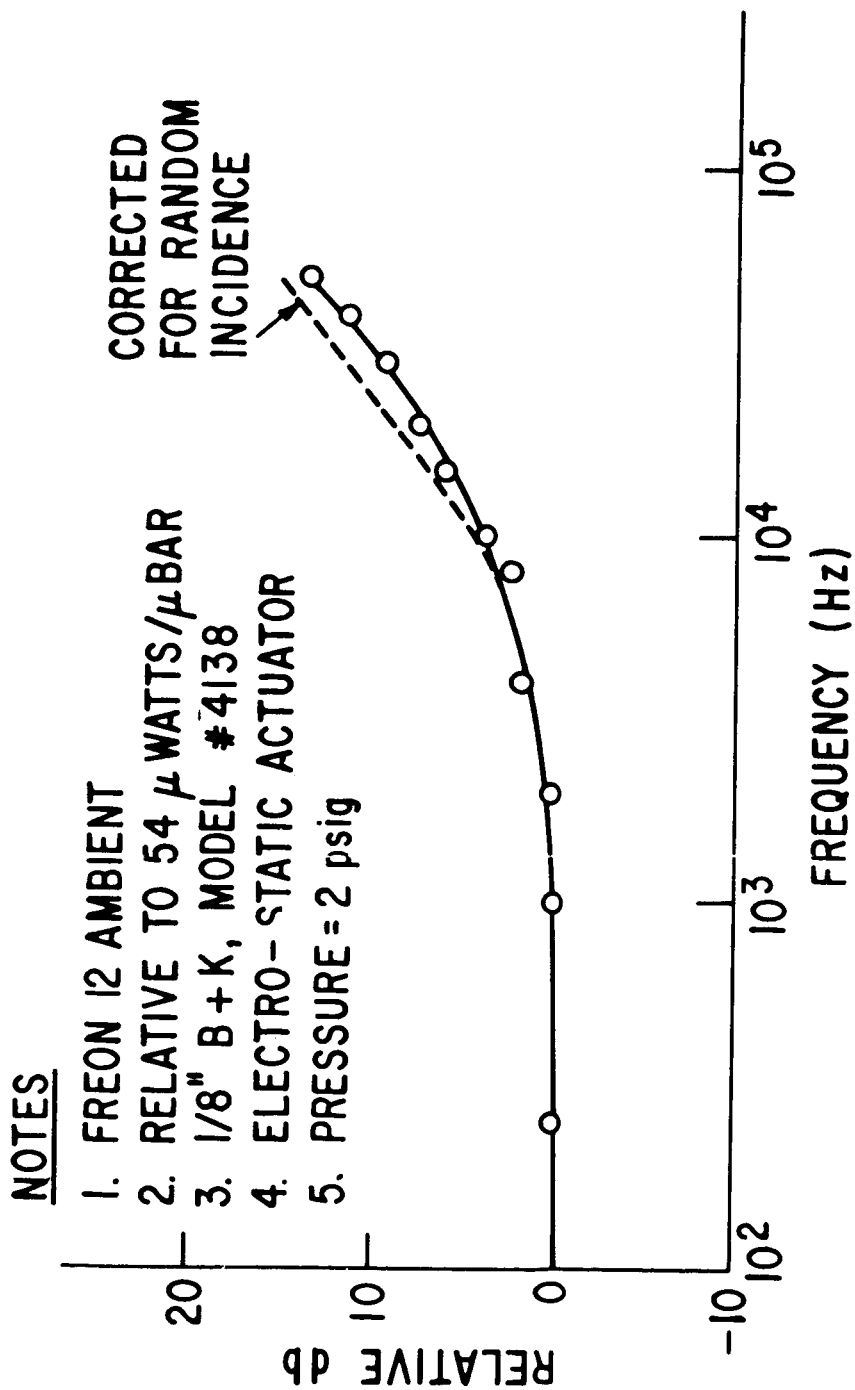


Figure 14. Calibration Curve of the Plenum Microphone.

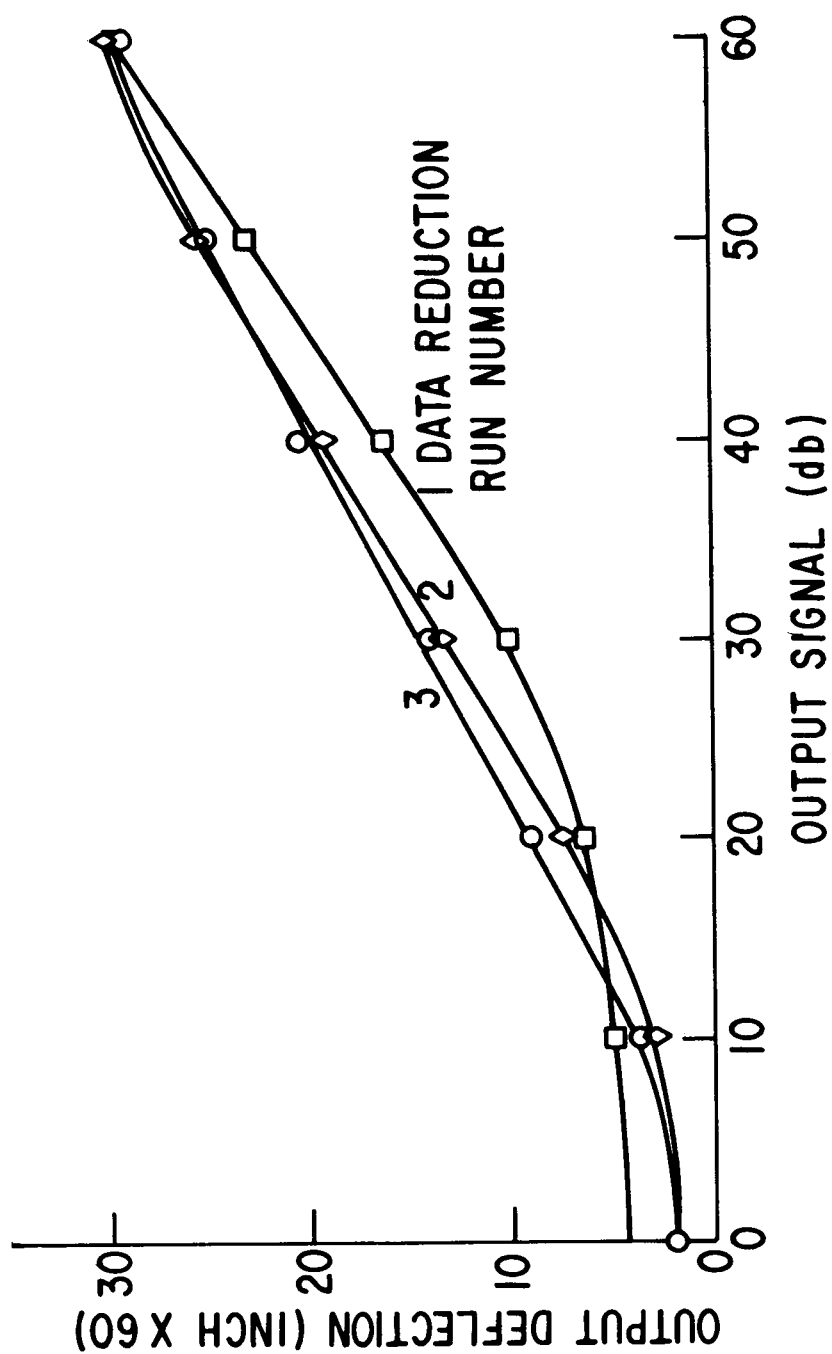


Figure 15. Spectral Analyzer CRT Output Characteristics.

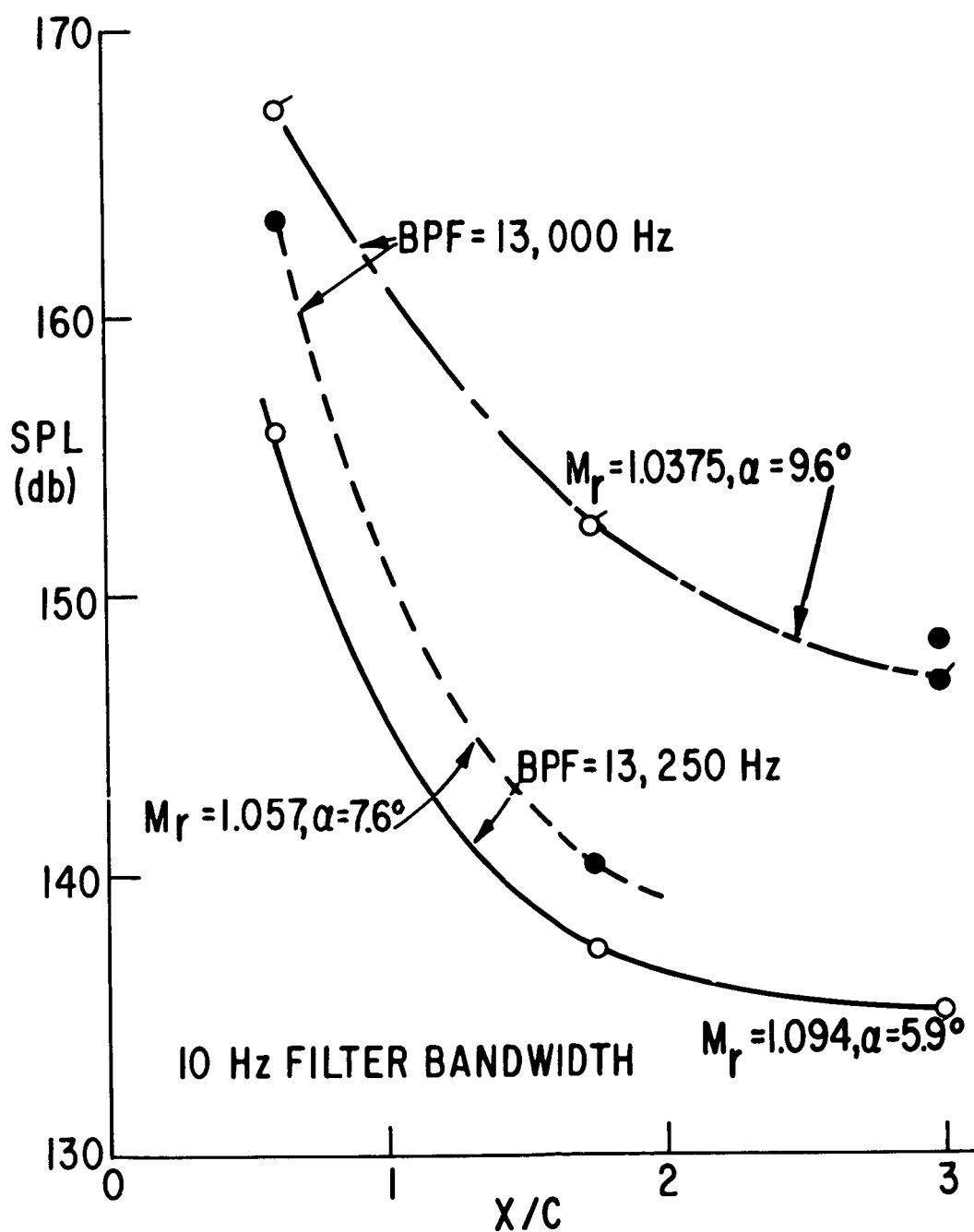


Figure 16. BPF Noise Versus Axial Distance.

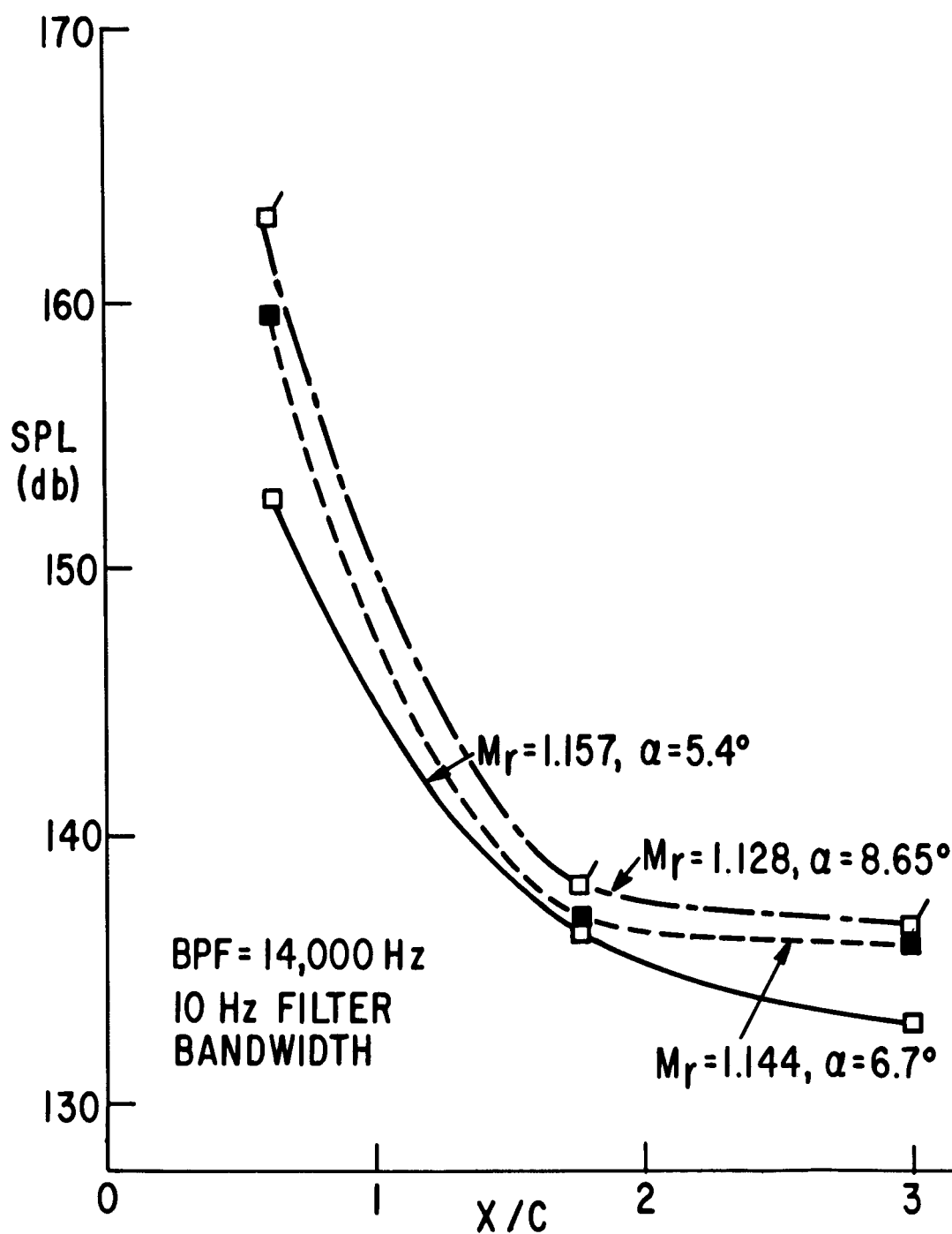


Figure 17. BPF Noise Versus Axial Distance.

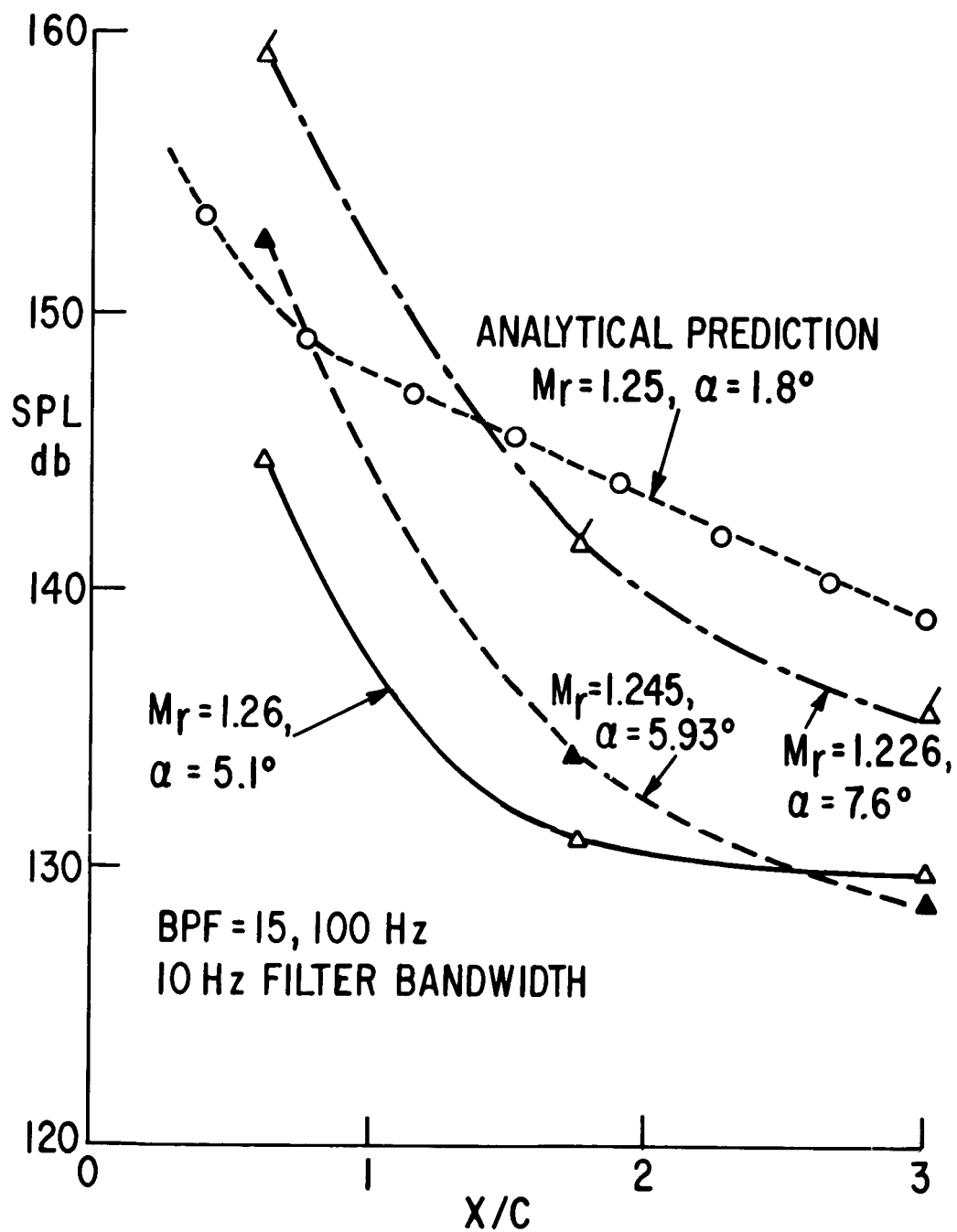


Figure 18. BPF Noise Versus Axial Distance.

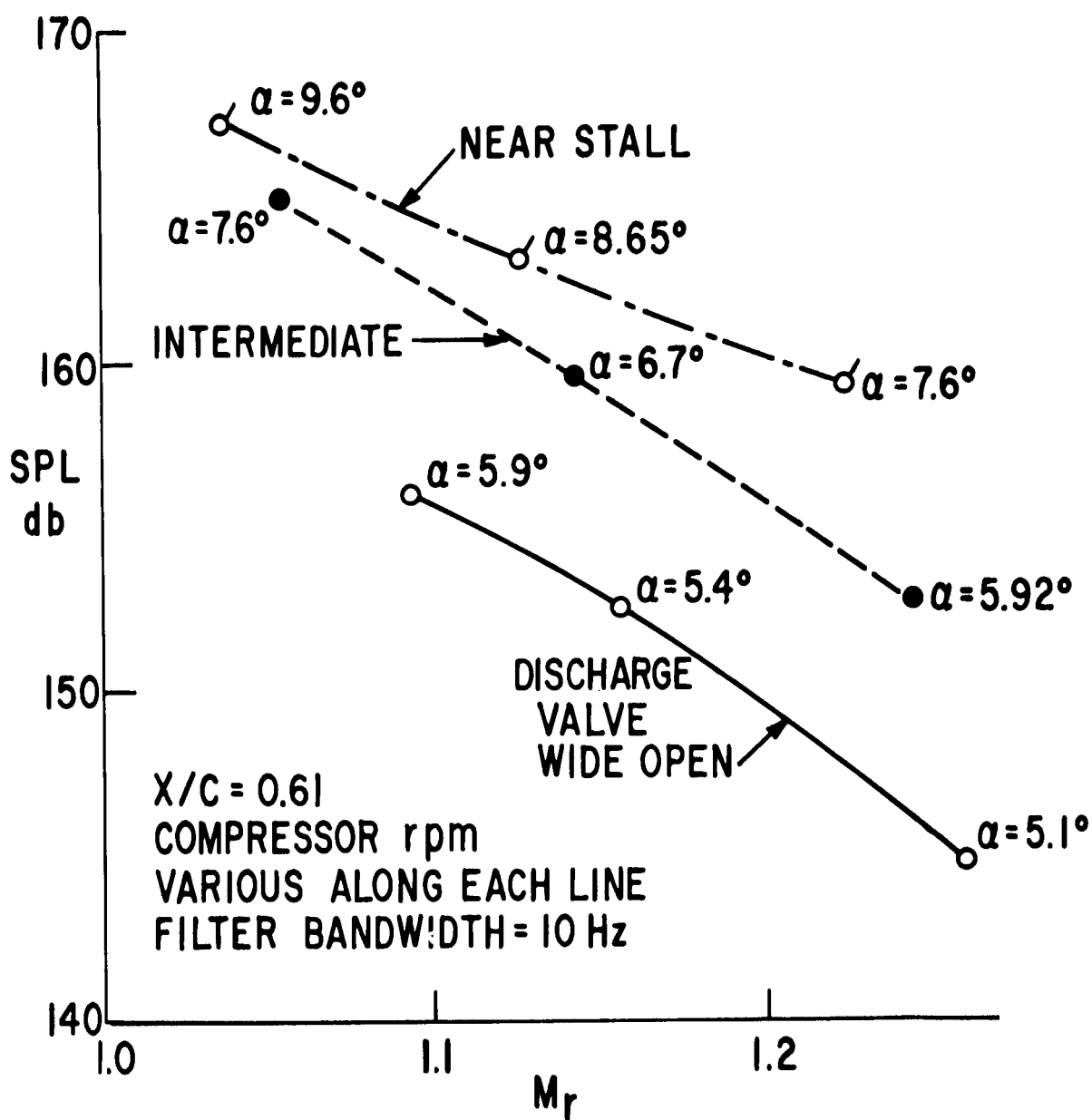


Figure 19. BPF Noise Versus Relative Mach Number.

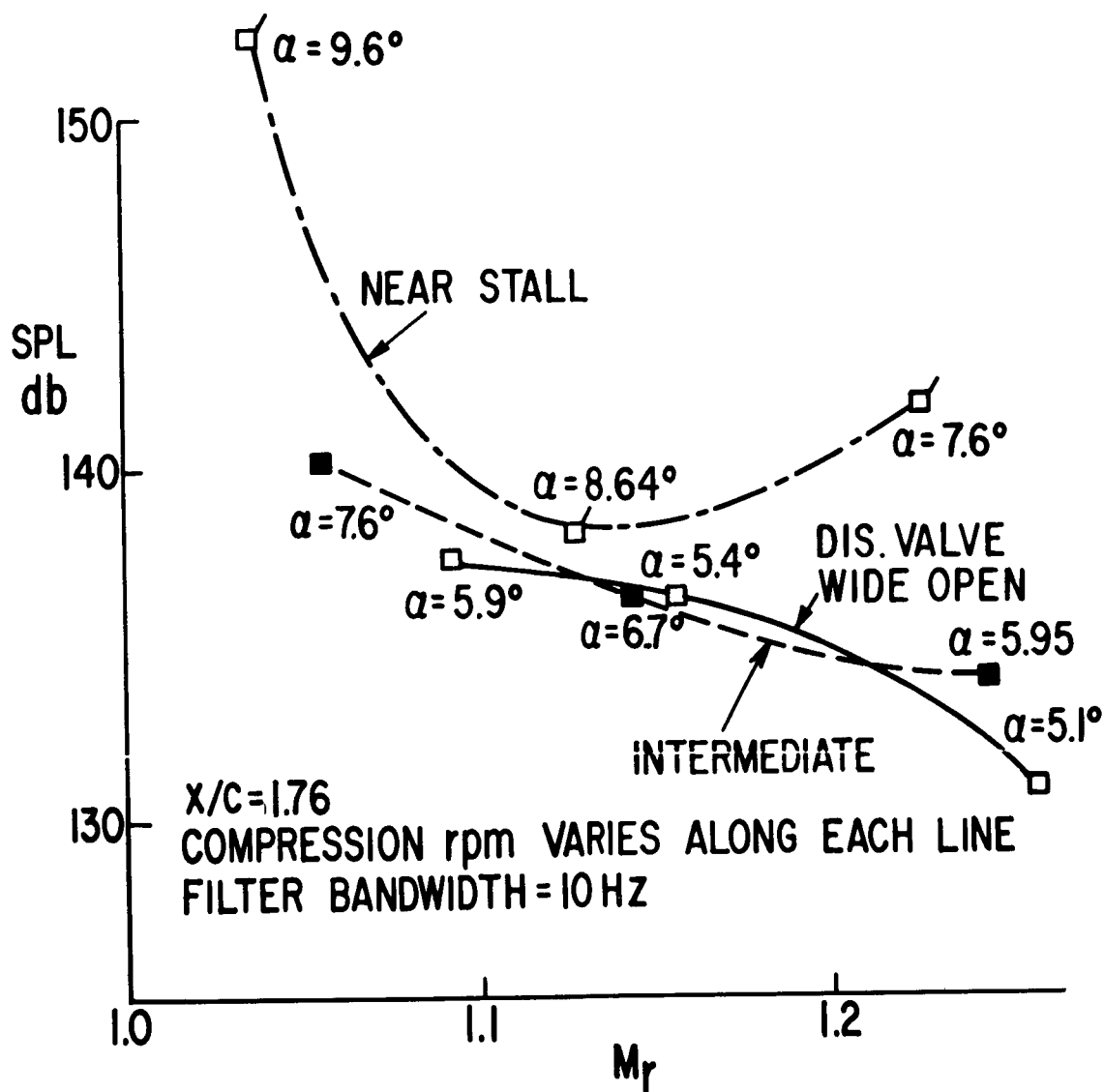


Figure 20. BPF Noise Versus Relative Mach Number.

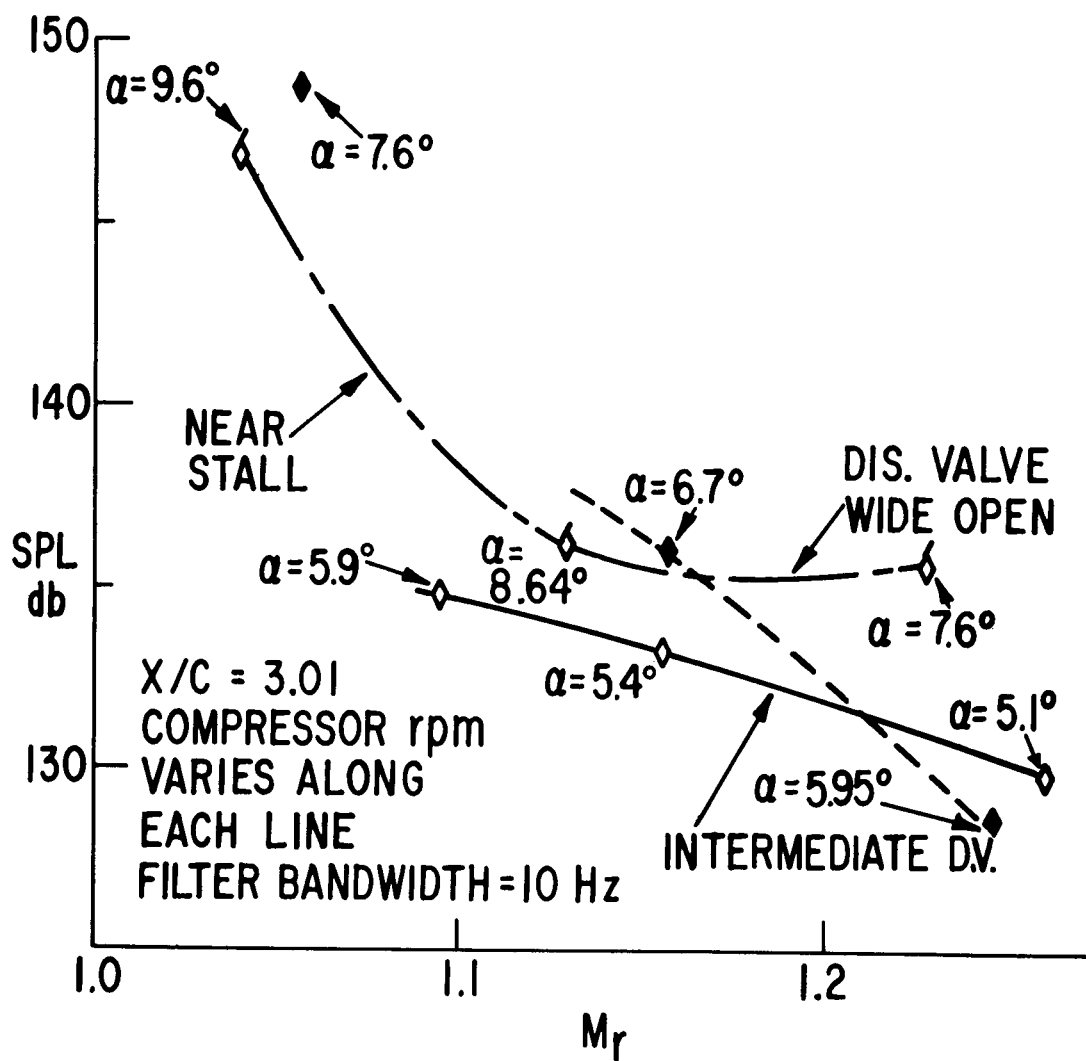
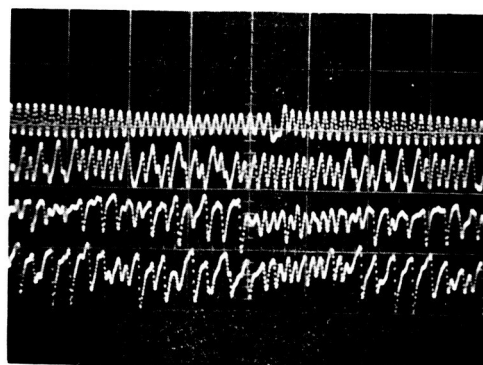


Figure 21. BPF Noise Versus Relative Mach Number.

Tach.
 $x/c = 0.61$
 $x/c = 1.76$
 $x/c = 3.01$



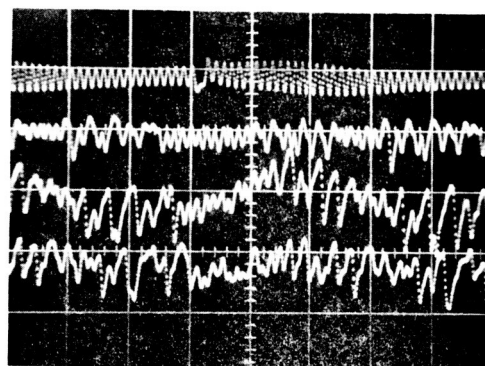
BPF = 13.25 KHz

5 psi/cm

2 psi/cm

2 psi/cm

Tach.
 $x/c = 0.61$
 $x/c = 1.76$
 $x/c = 3.01$



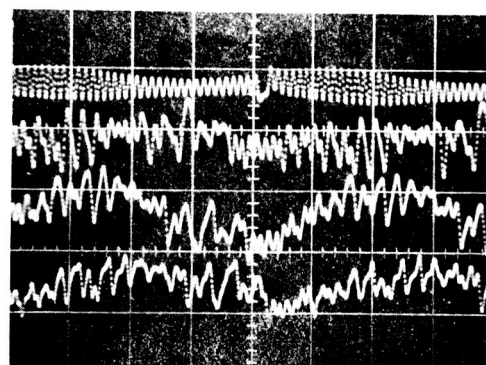
BPF = 14 KHz

5 psi/cm

2 psi/cm

2 psi/cm

Tach.
 $x/c = 0.61$
 $x/c = 1.76$
 $x/c = 3.01$



BPF = 15.1 KHz

2 psi/cm

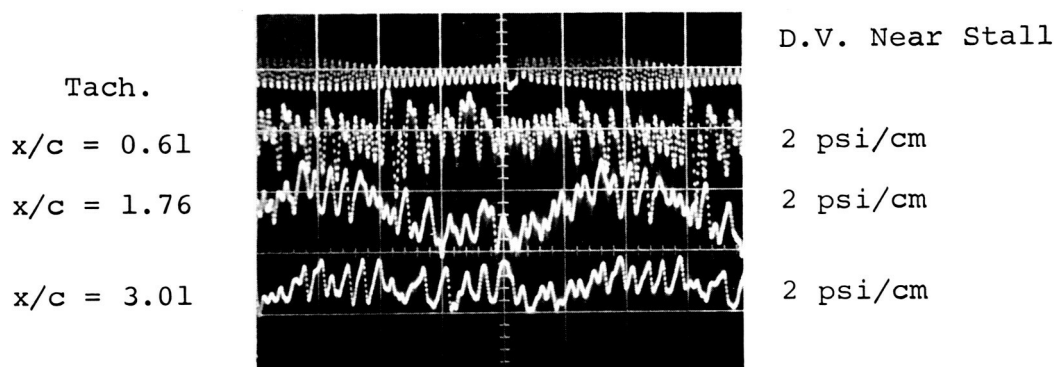
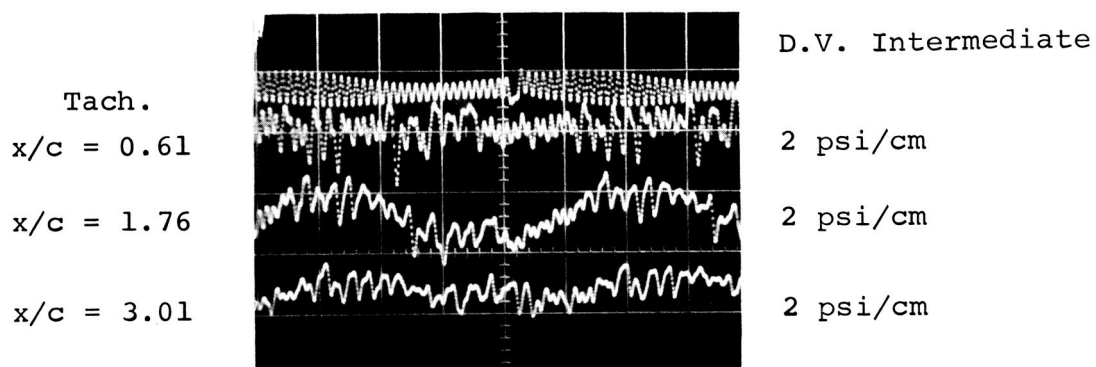
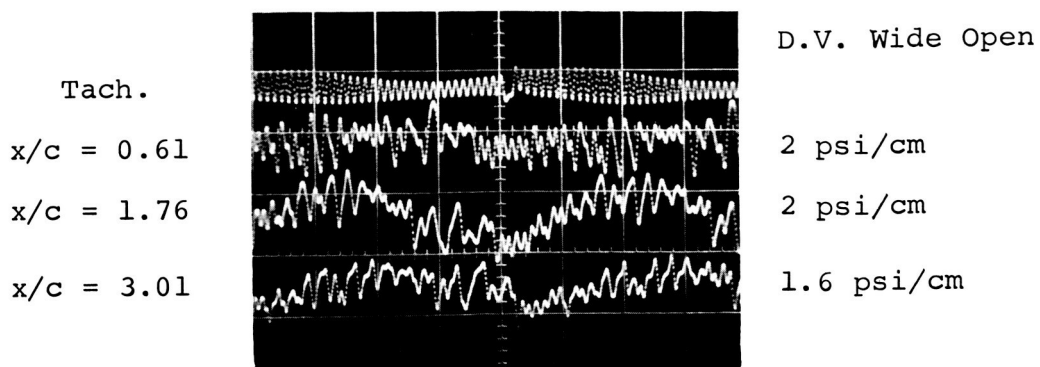
2 psi/cm

1.6 psi/cm

Time —————
 0.5 ms/cm

Discharge Valve Wide Open

Figure 22 . Wall Static Pressure Traces in the Long Inlet Duct.



Time 0.5 ms/cm
BPF = 15.1 KHz

Figure 23. Wall Static Pressure Traces in the Long Inlet Duct.

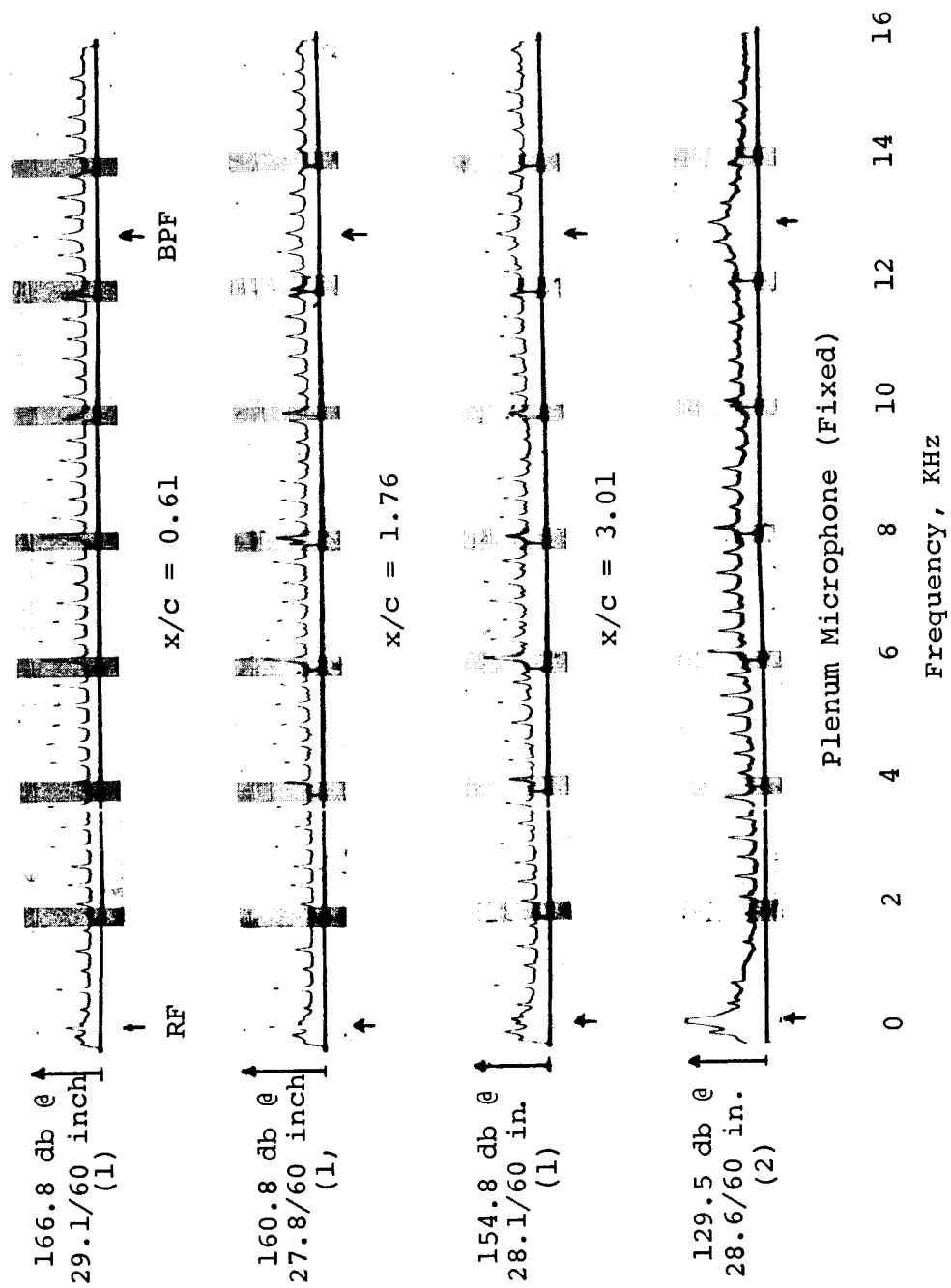


Figure 24. Wall Static SPL Spectrum, BPF = 13.25 KHz, High Flow, Flow Conditions - $Mr = 1.094$, $\alpha = 5.9^\circ$.

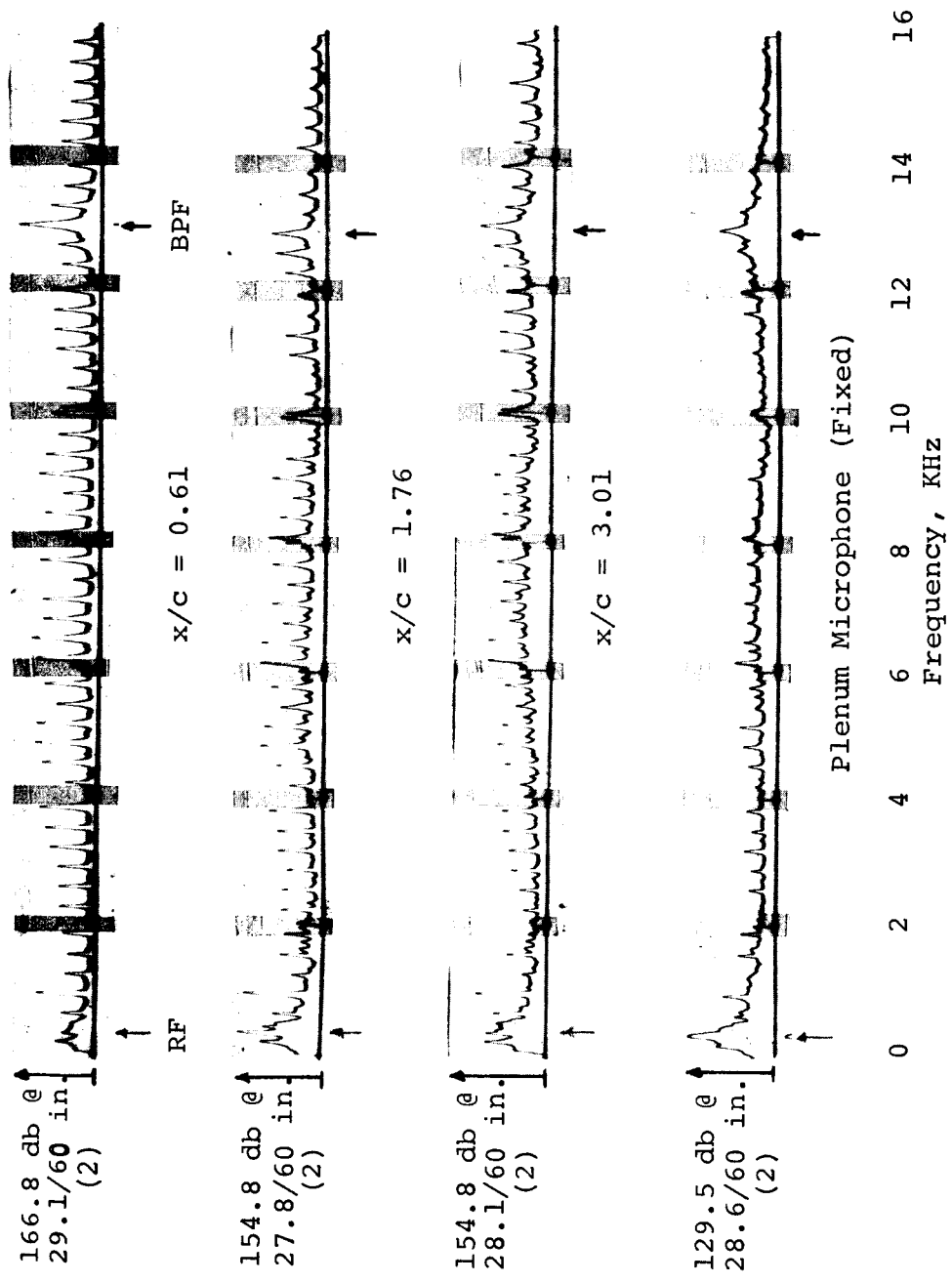


Figure 25. Wall Static SPL Spectrum, BPF = 13 KHz, Intermediate Flow, Flow Conditions - $Mr = 1.056$, $\alpha = 7.6^\circ$.

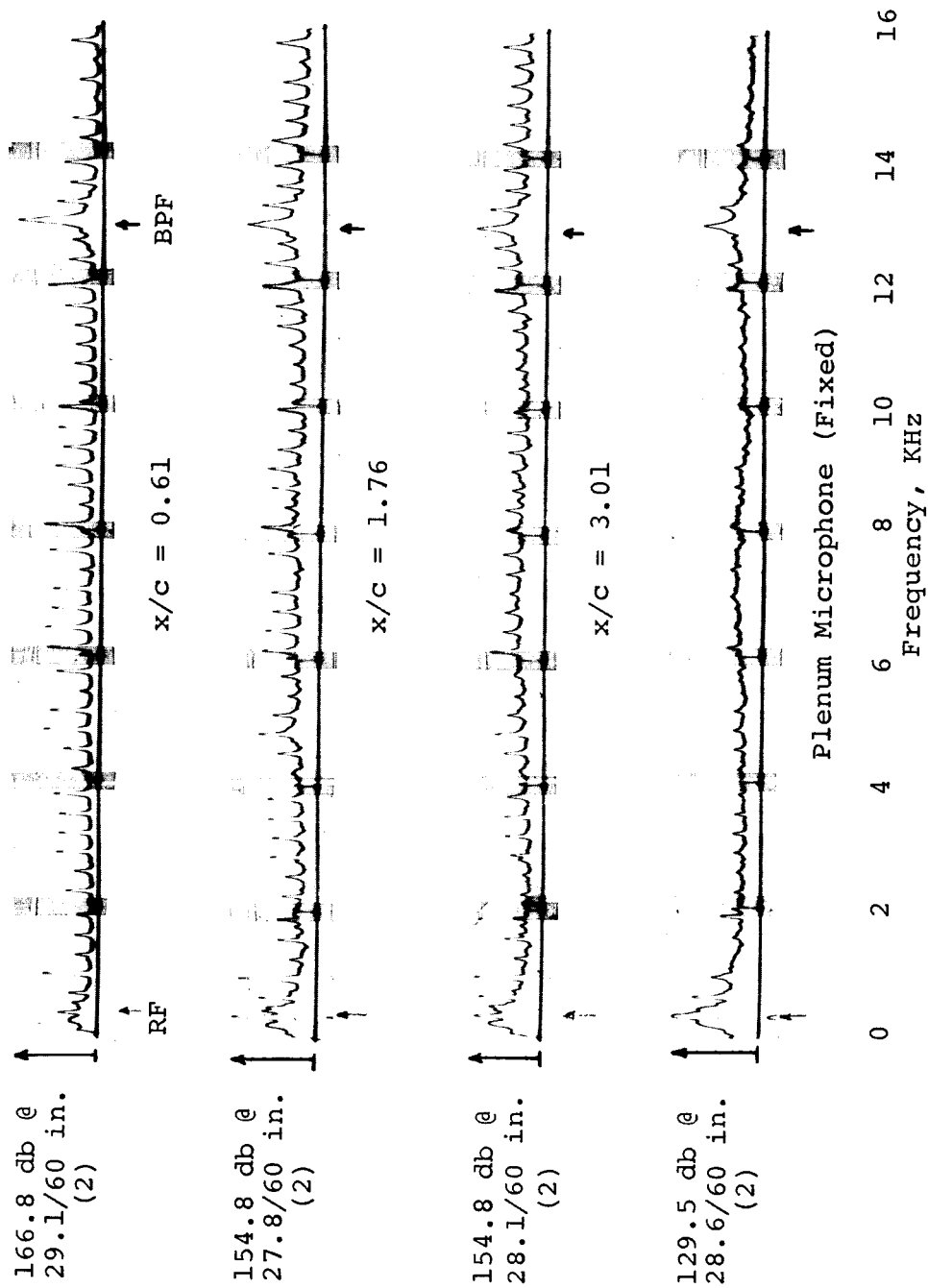


Figure 26. Wall Static SPL Spectrum, BPF = 13 KHz, Near Stall, Flow Conditions - $Mr = 1.037$, $\alpha = 9.6^\circ$.

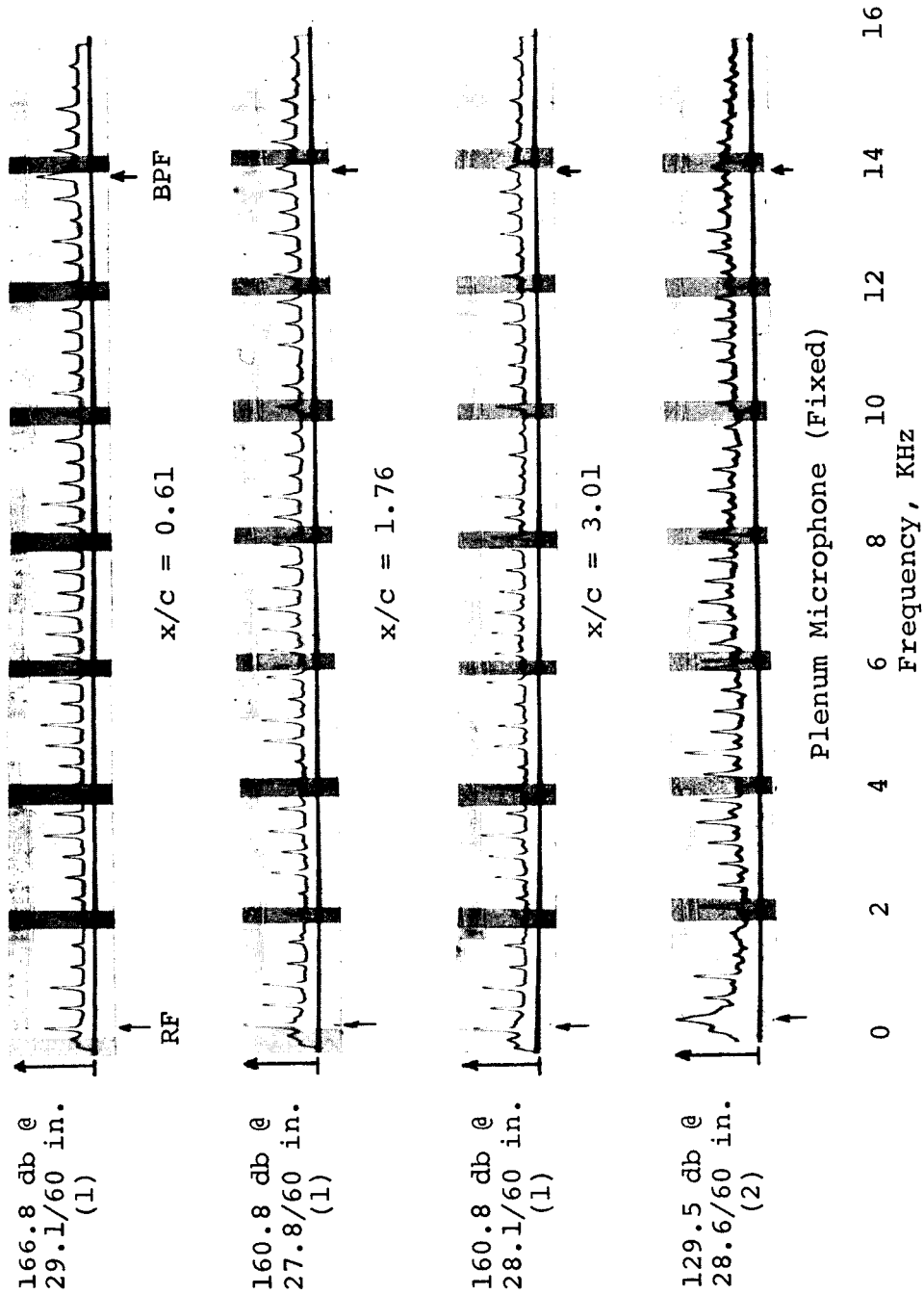


Figure 27. Wall Static SPL Spectrum, BPF = 14 KHz, High Flow, Flow Conditions - $Mr = 1.158$, $\alpha = 5.4^\circ$.

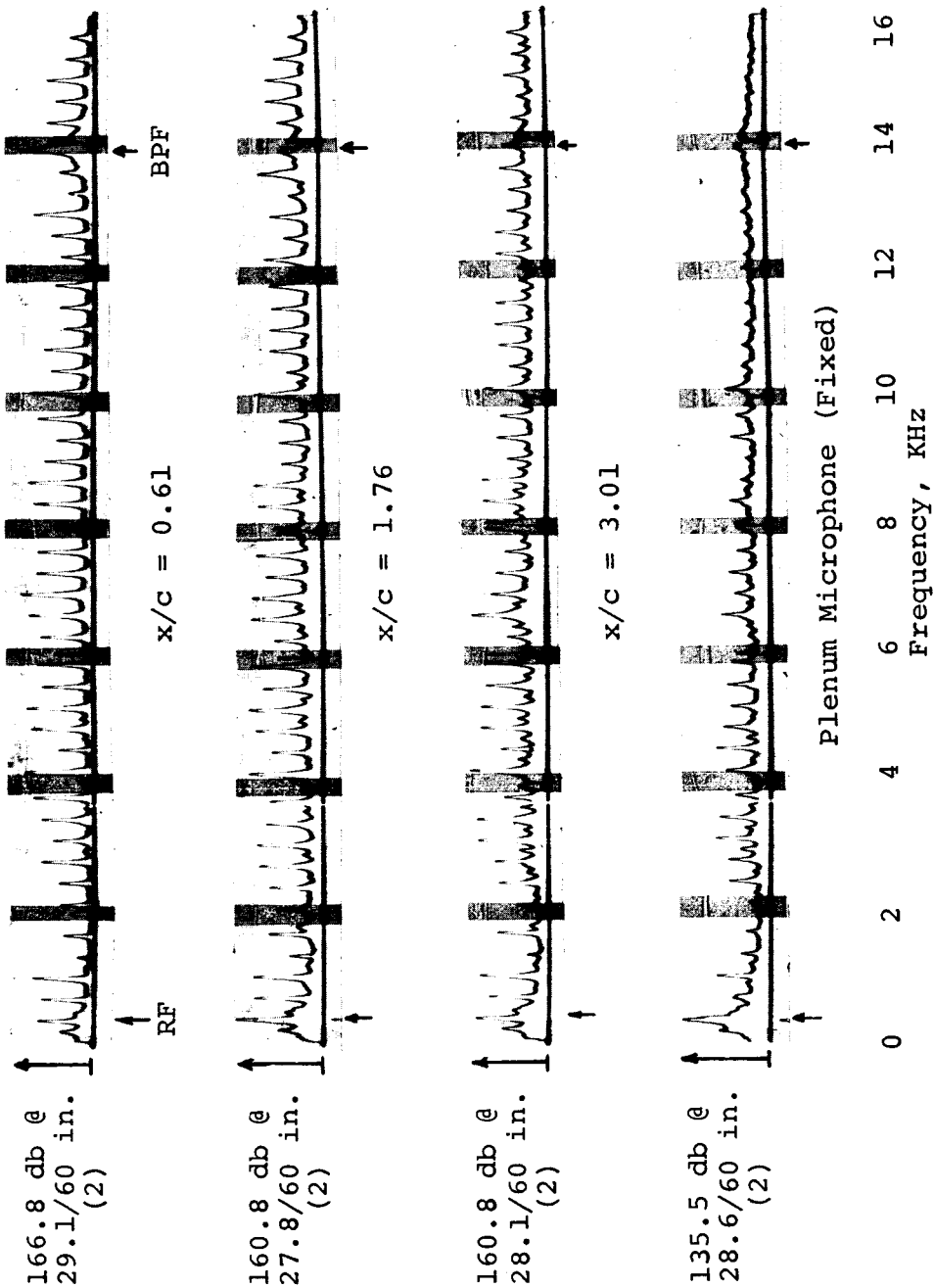


Figure 28. Wall Static SPL Spectrum, BPF = 14 KHz, Intermediate Flow, Flow Conditions - $Mr = 1.144$, $\alpha = 6.7^\circ$.

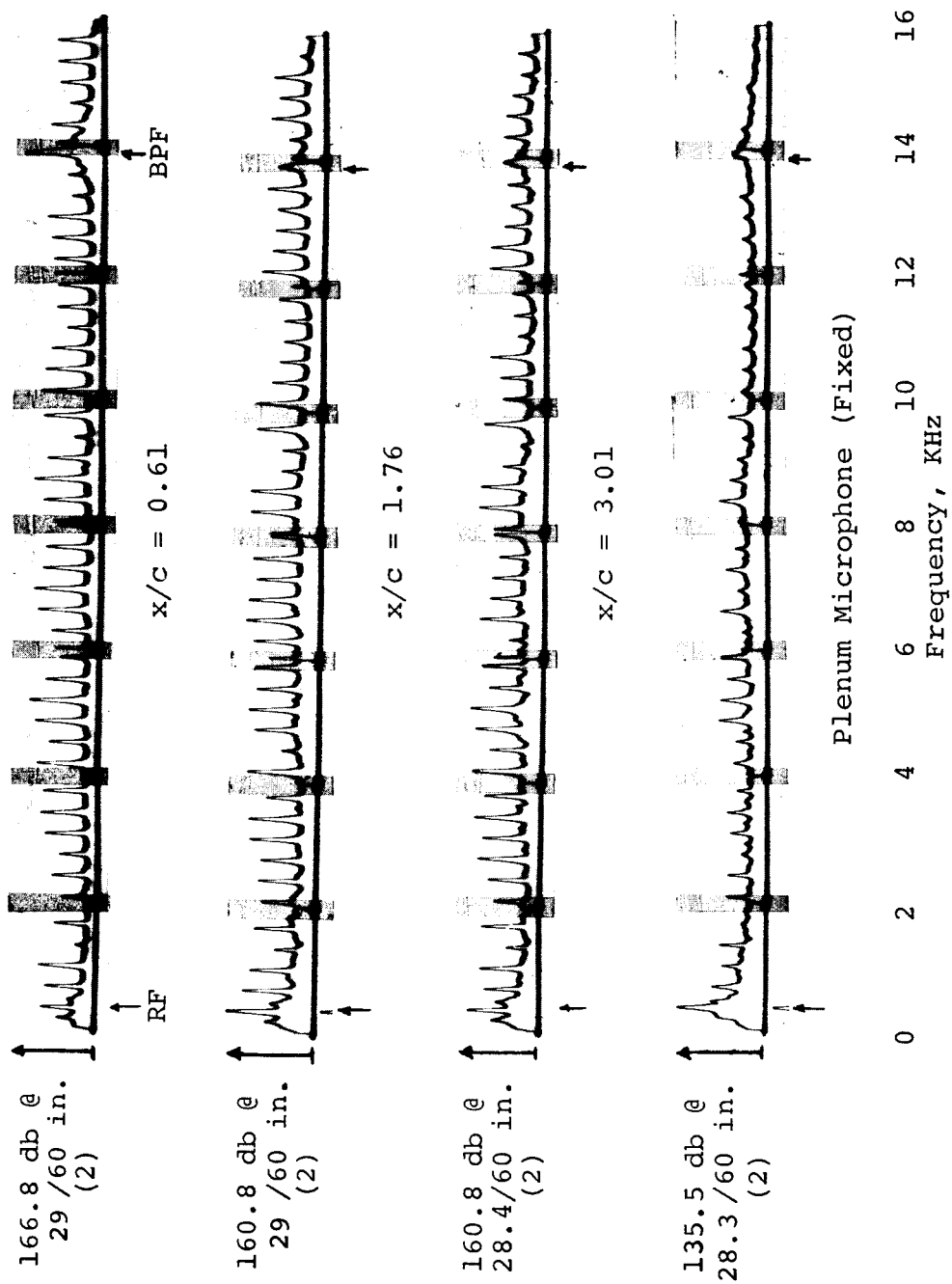


Figure 29. Wall Static SPL Spectrum, BPF = 14 KHz, Near Stall, Flow Conditions - $Mr = 1.128$, $\alpha = 8.65^\circ$.

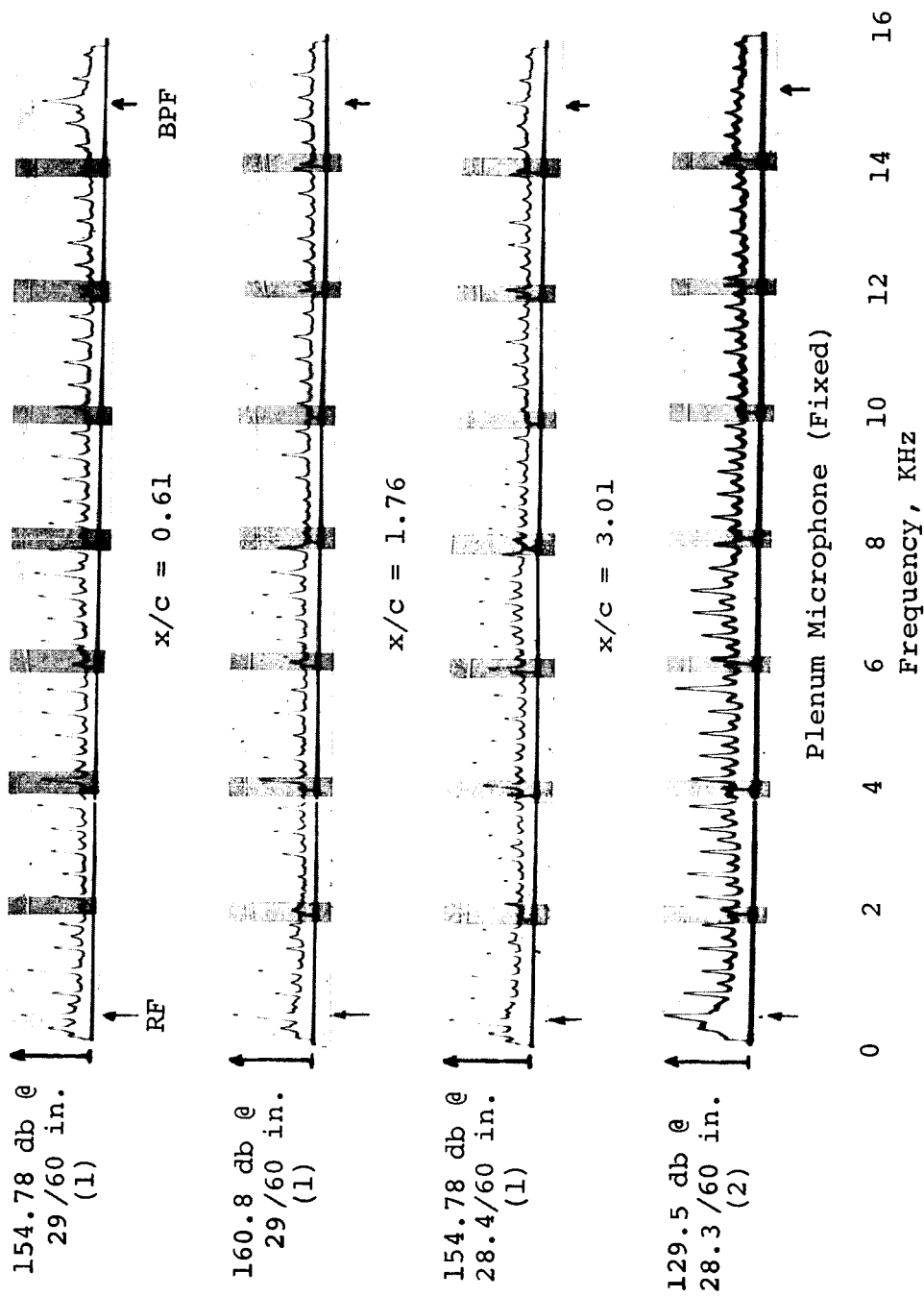


Figure 30. Wall Static SPL Spectrum, BPF = 15.1 KHz, High Flow,
Flow Conditions - $Mr = 1.26$, $\alpha = 5.1^\circ$.

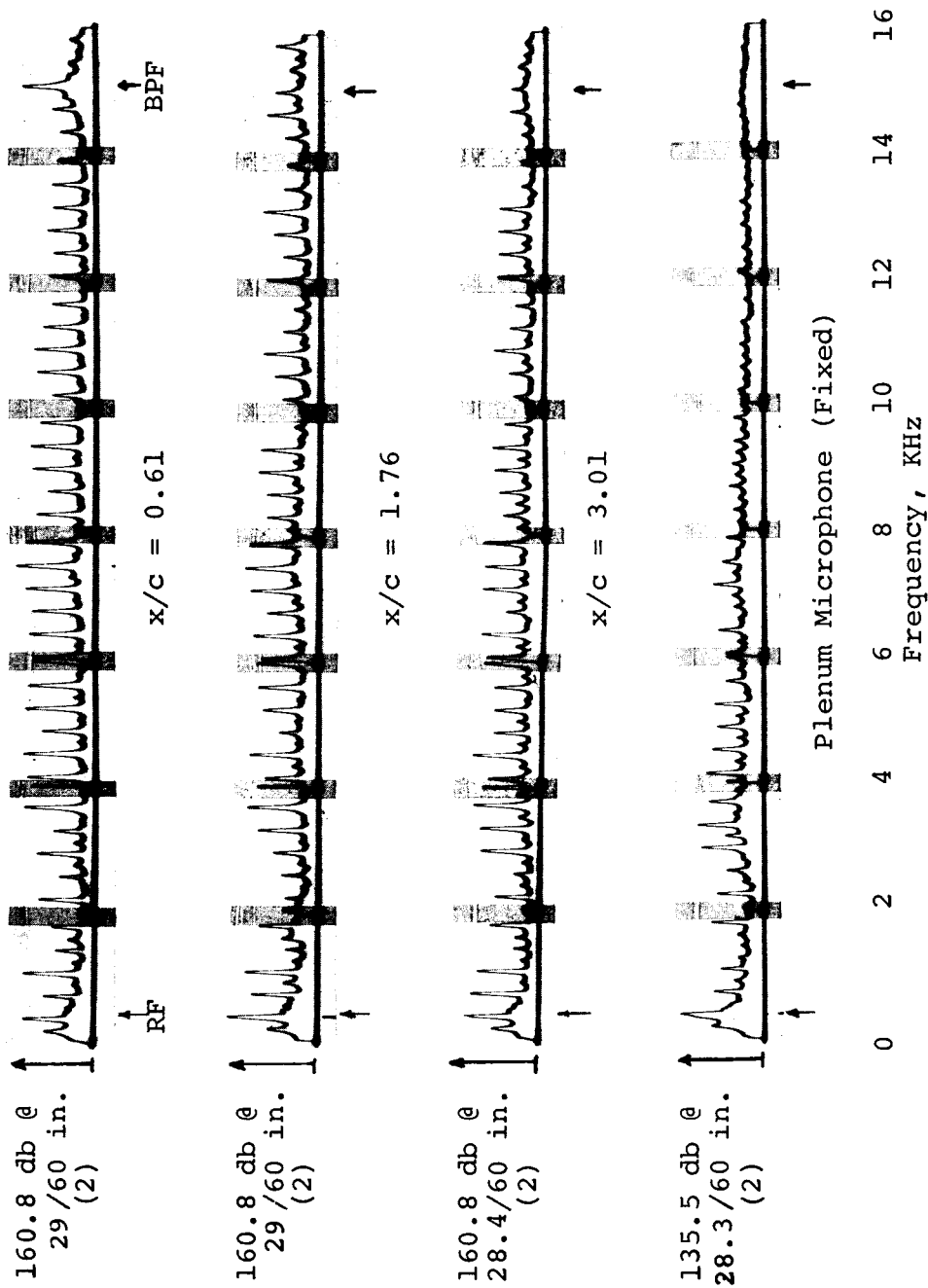


Figure 31. Wall Static SPL Spectrum, BPF = 15.1 KHz, Intermediate Flow, Flow Conditions - $Mr = 1.245$, $\alpha = 5.96^\circ$.

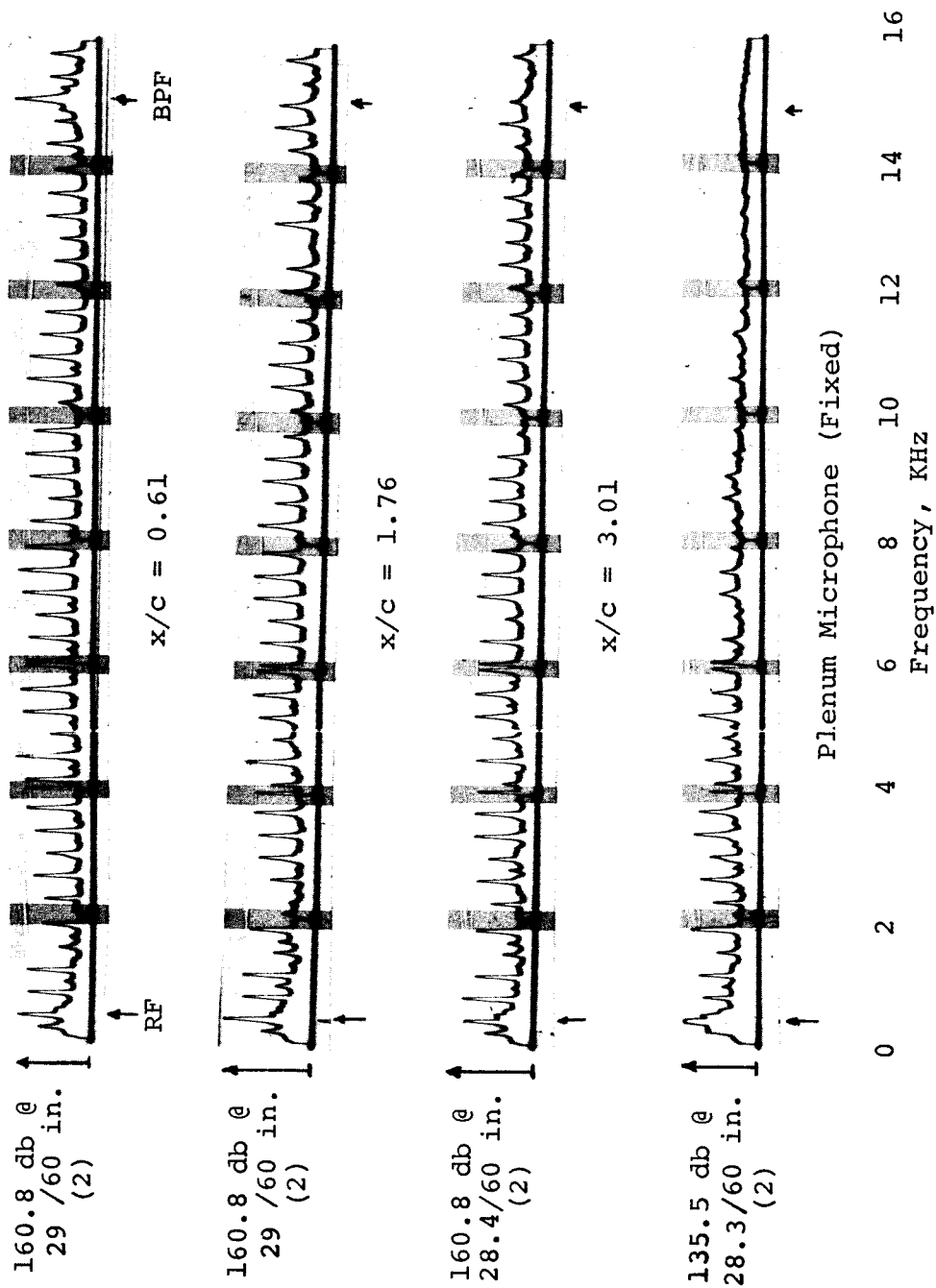


Figure 32. Wall Static SPL Spectrum, BPF = 15.1 KHz, Near Stall, Flow Conditions - $Mr = 1.226$, $\alpha = 7.6^\circ$.

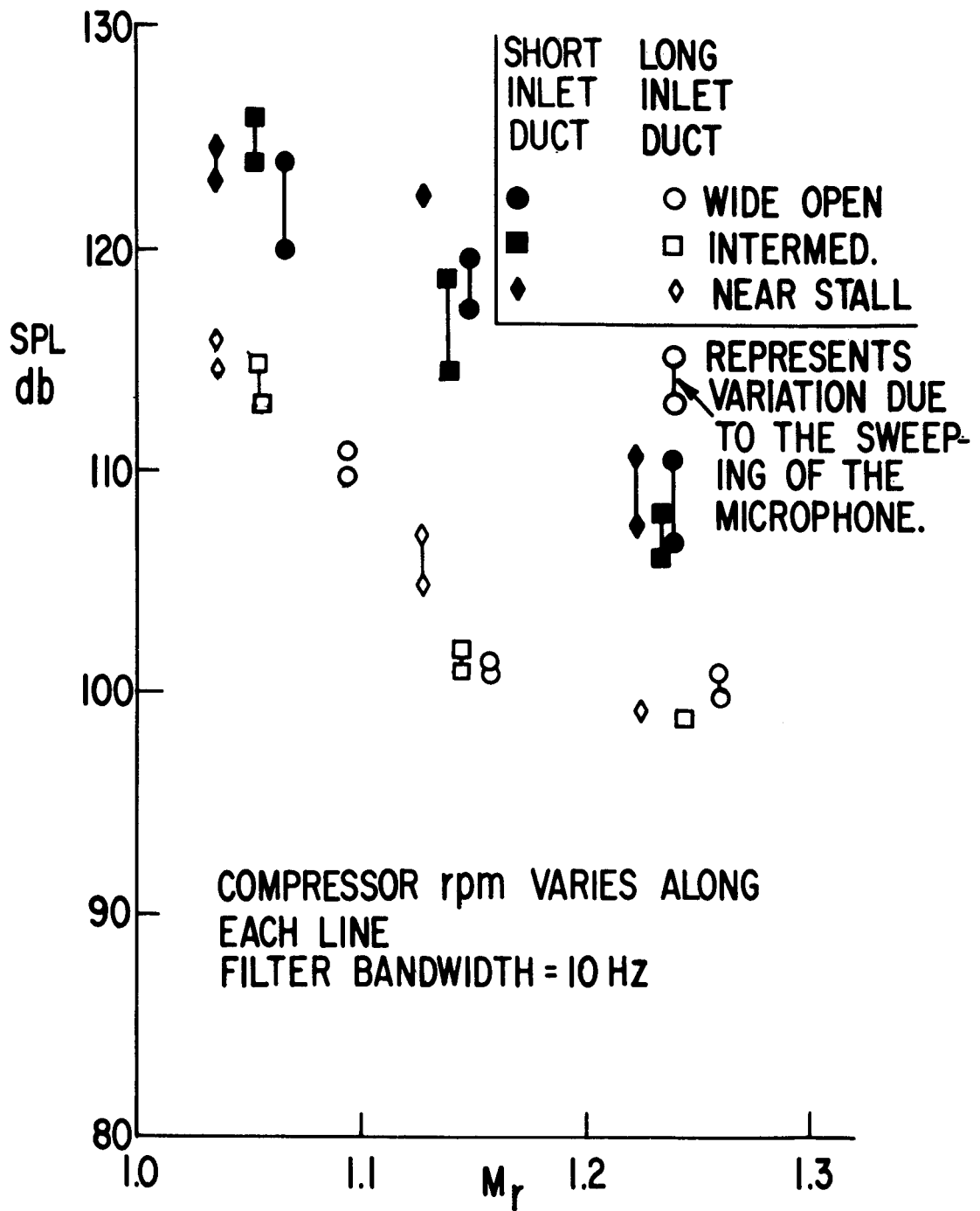


Figure 33. Plenum BPF Noise Versus Mach Number.

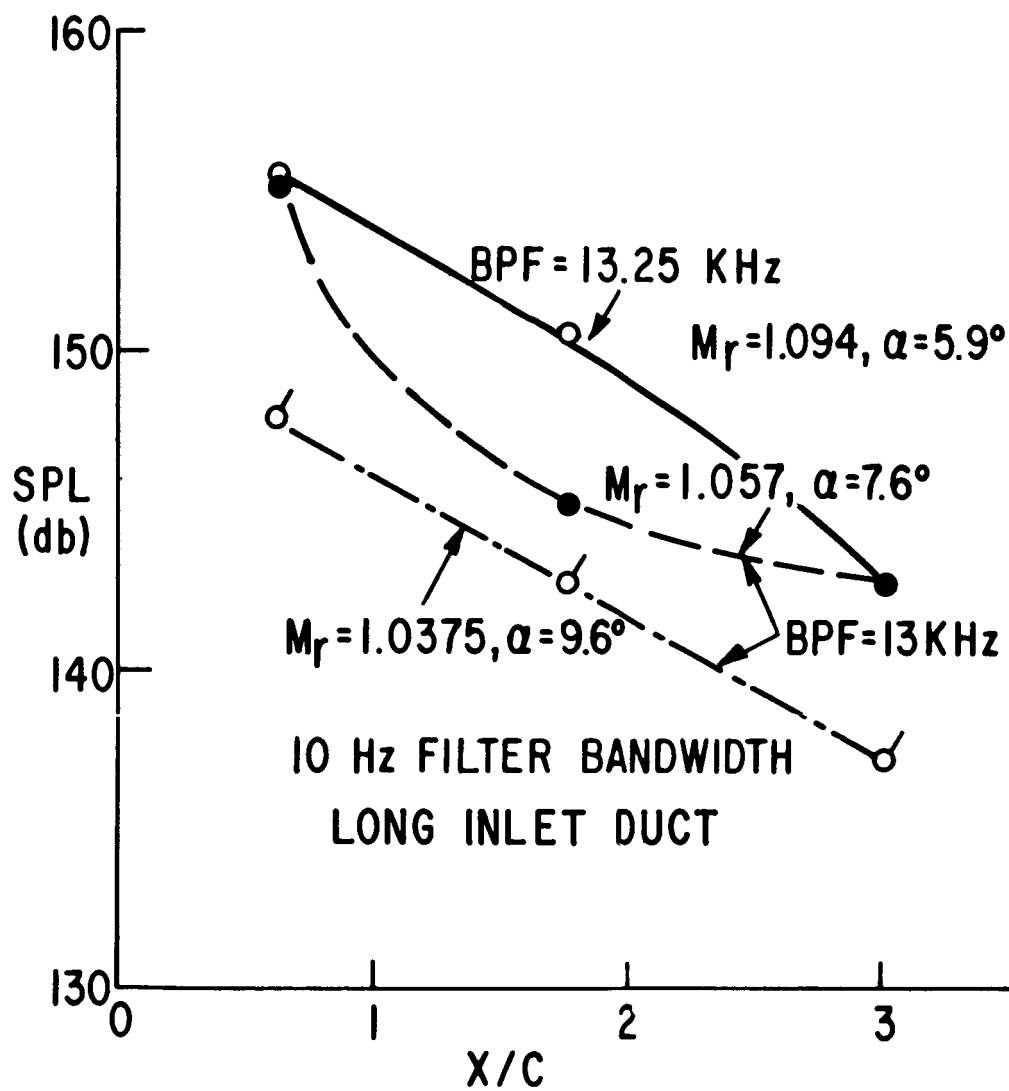


Figure 34. MPT Noise Versus Axial Distance, Low Speed.

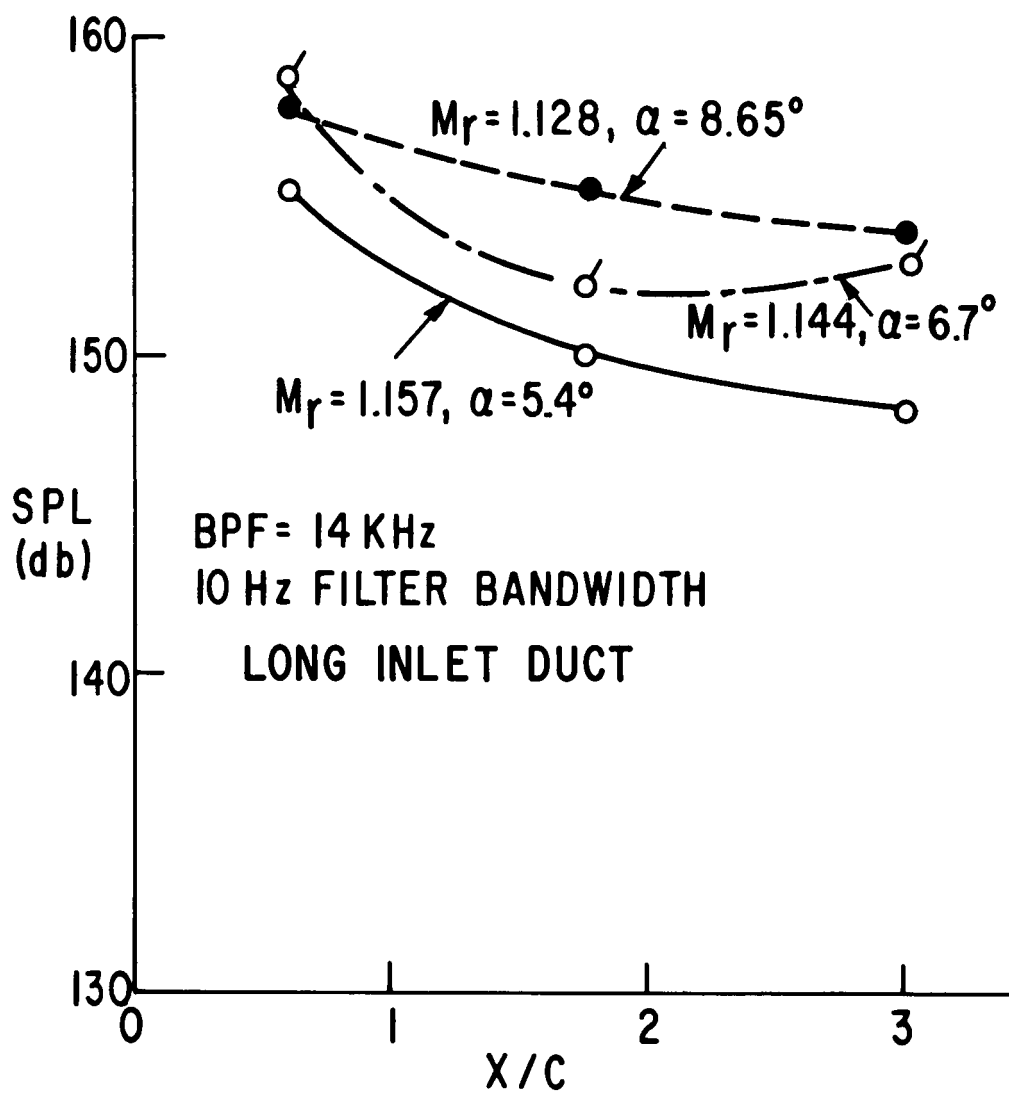


Figure 35. MPT Noise Versus Axial Distance, Intermediate Speed.

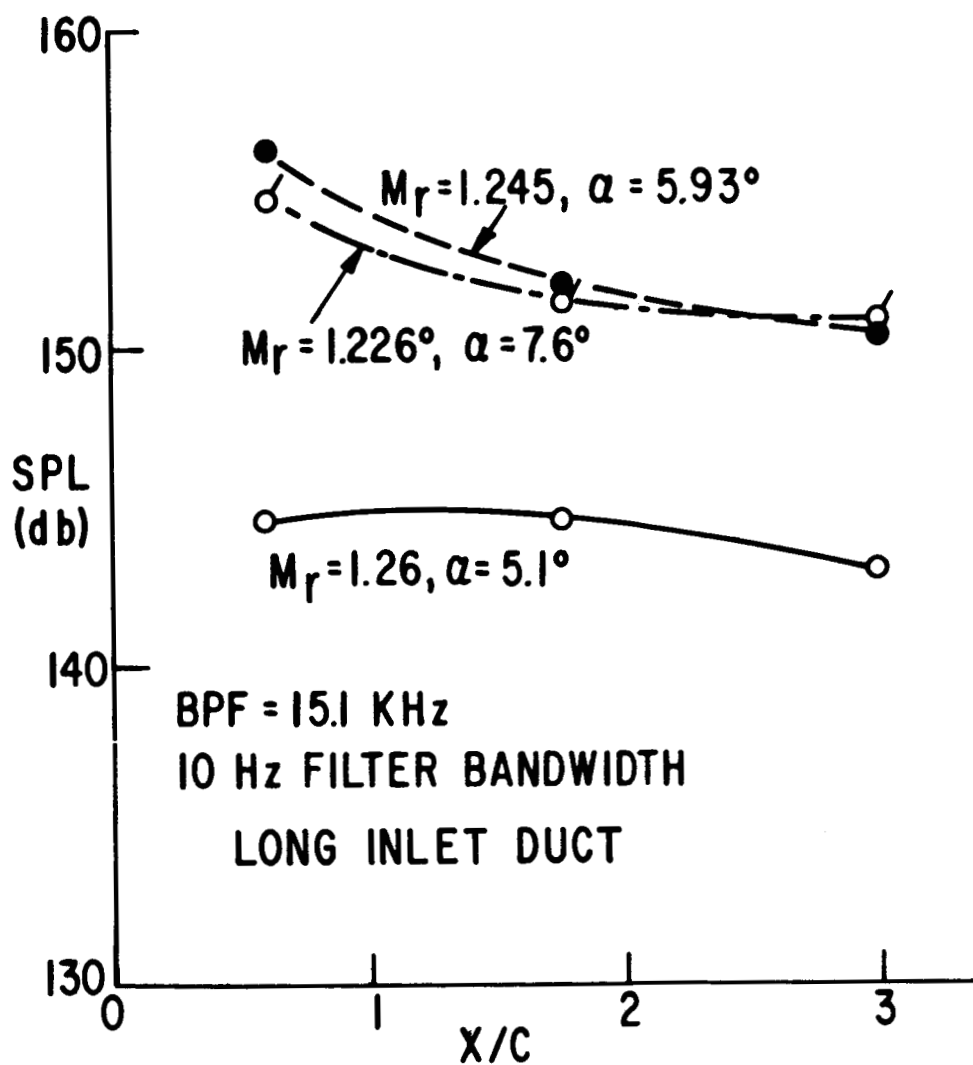


Figure 36. MPT Noise Versus Axial Distance, High Speed.

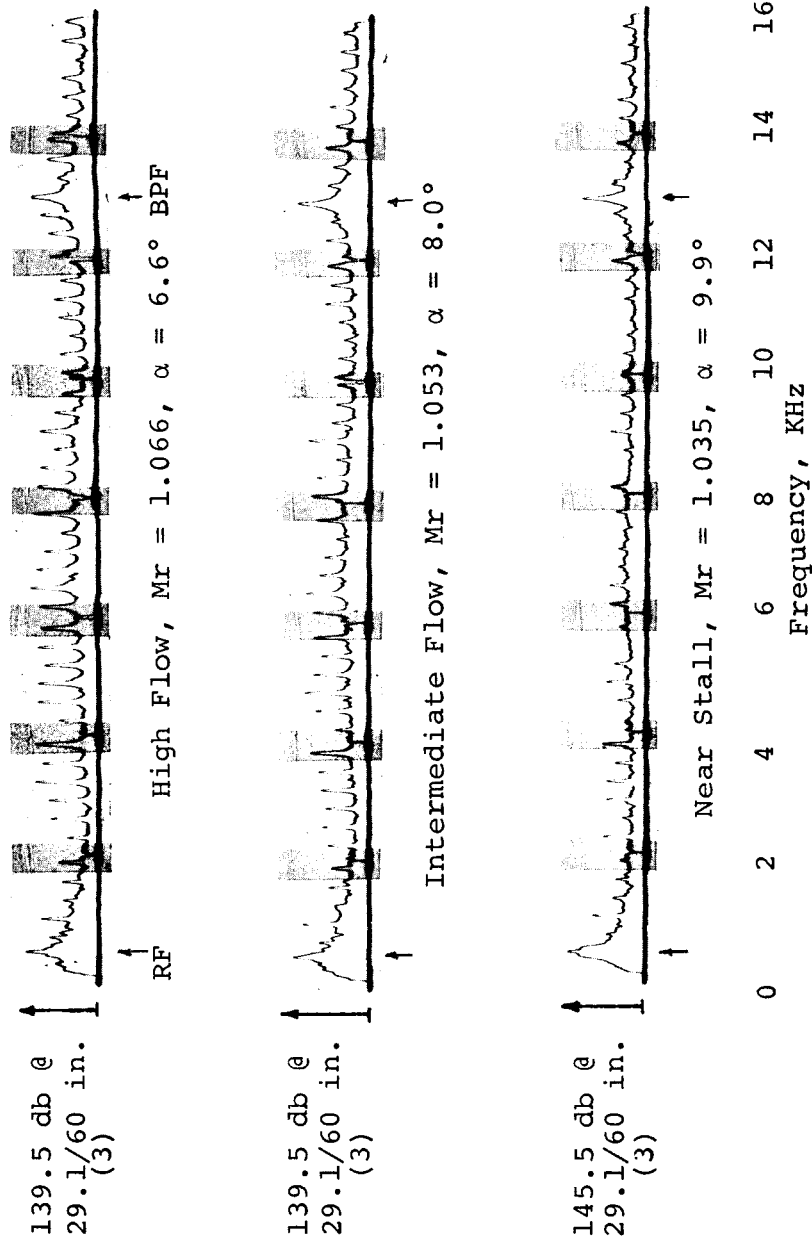


Figure 37. Plenum SPL Spectrum, Short Inlet, BPF = 13 KHz, Microphone Steady.

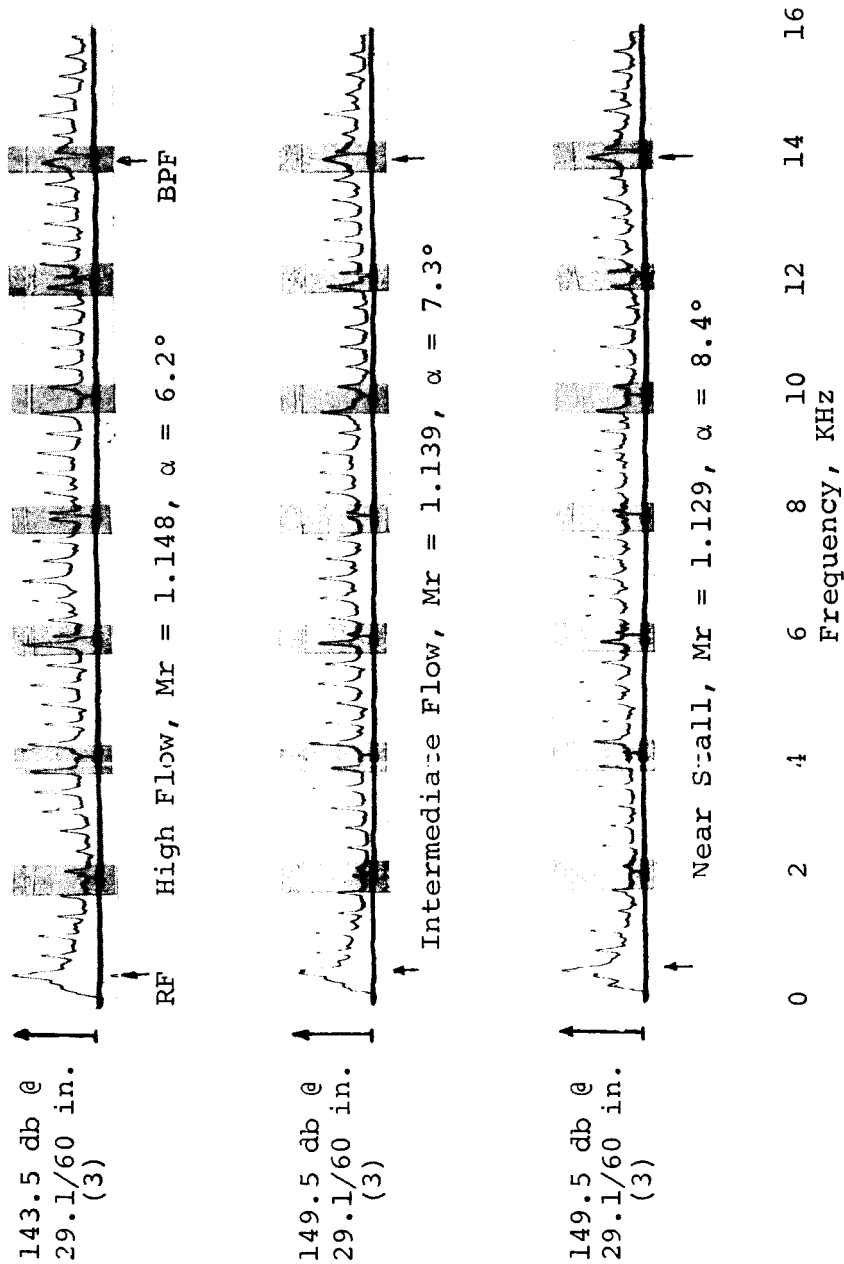


Figure 38. Plenum SPL Spectrum, Short Inlet, BPF = 14 KHz, Microphone Steady.

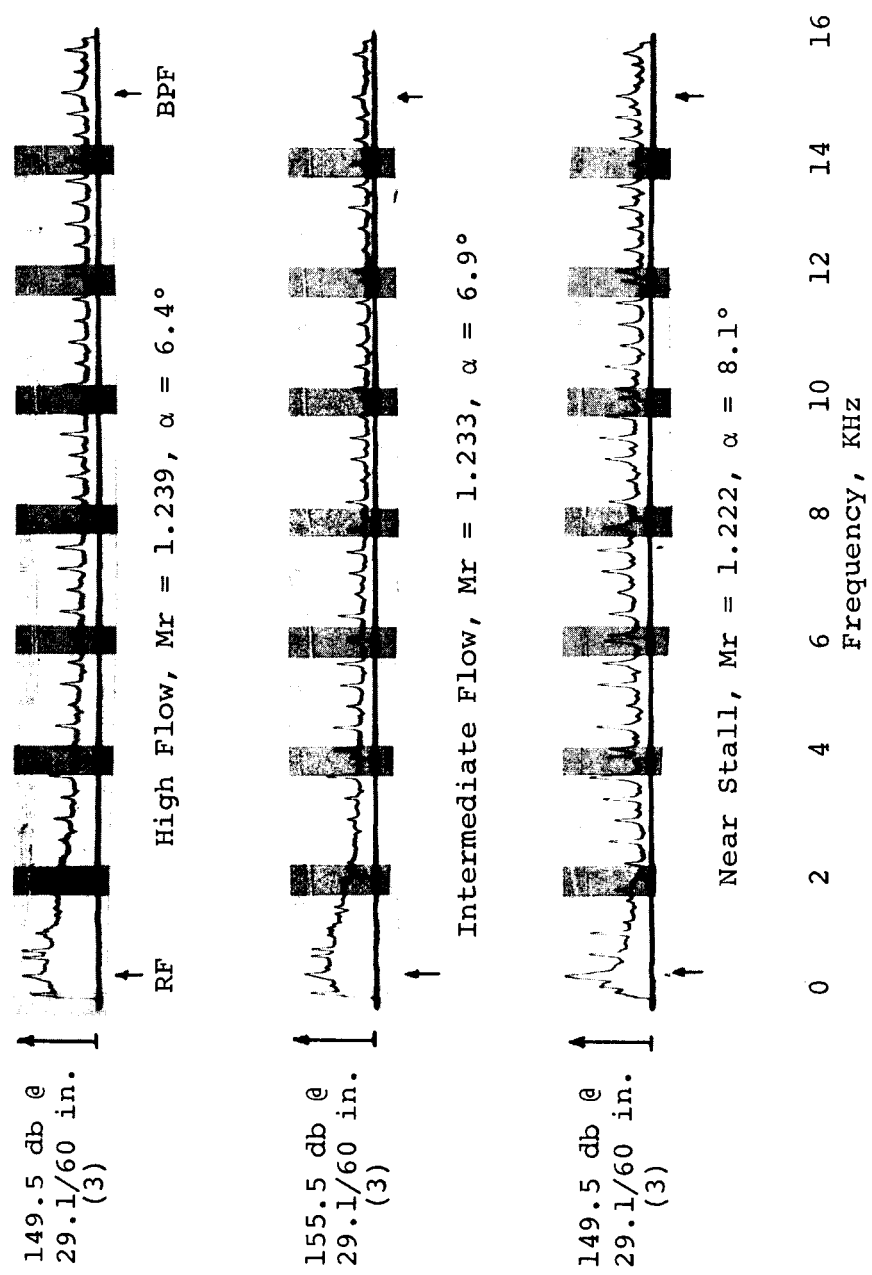


Figure 39. Plenum SPL Spectrum, Short Inlet, BPF = 15.1 KHz, Microphone Steady.

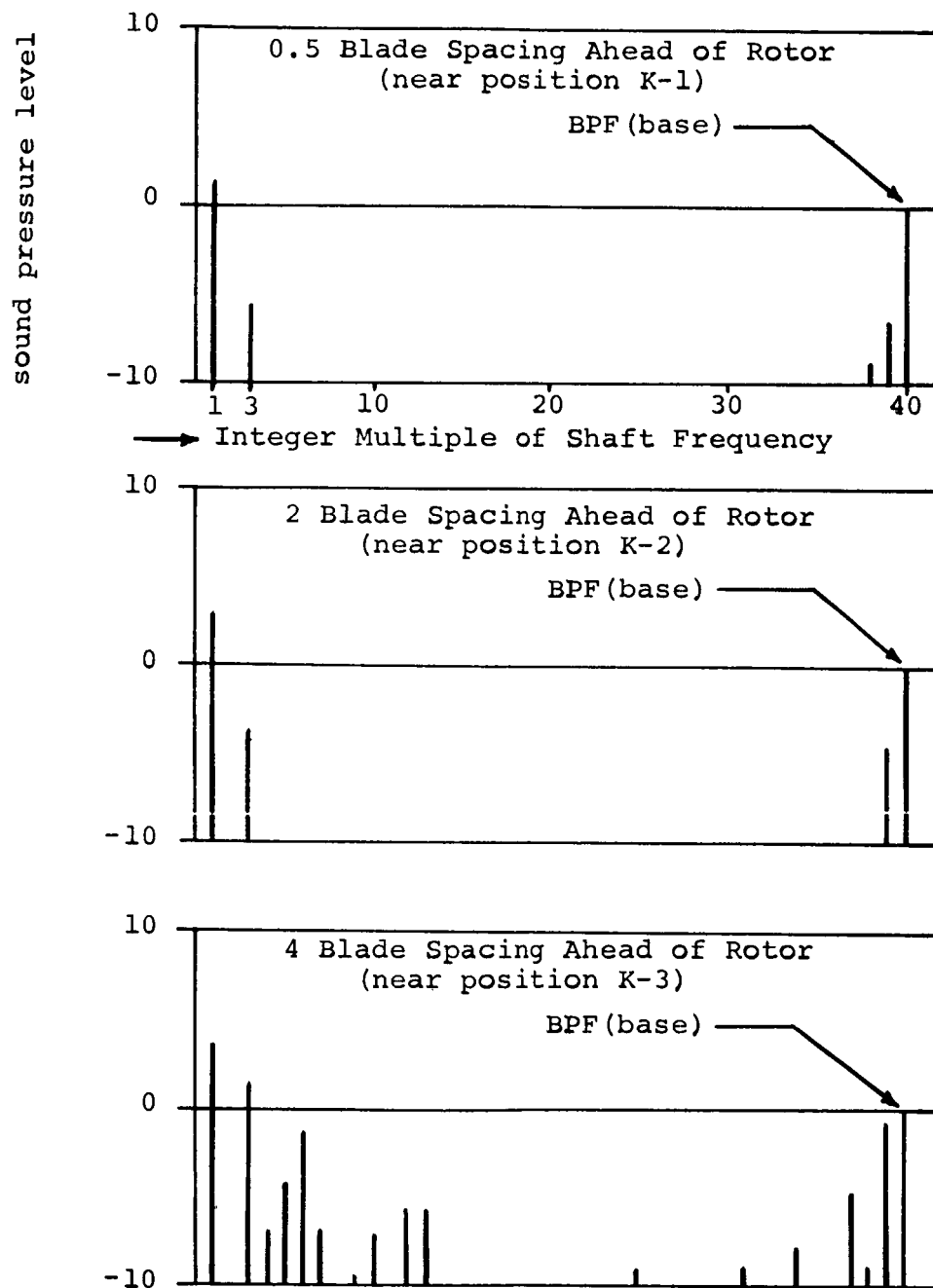


Figure 40. Computed Evolution of MPT for Model Rotor
($M_\infty = 1.25$, angle of attack = 1.8 degrees)

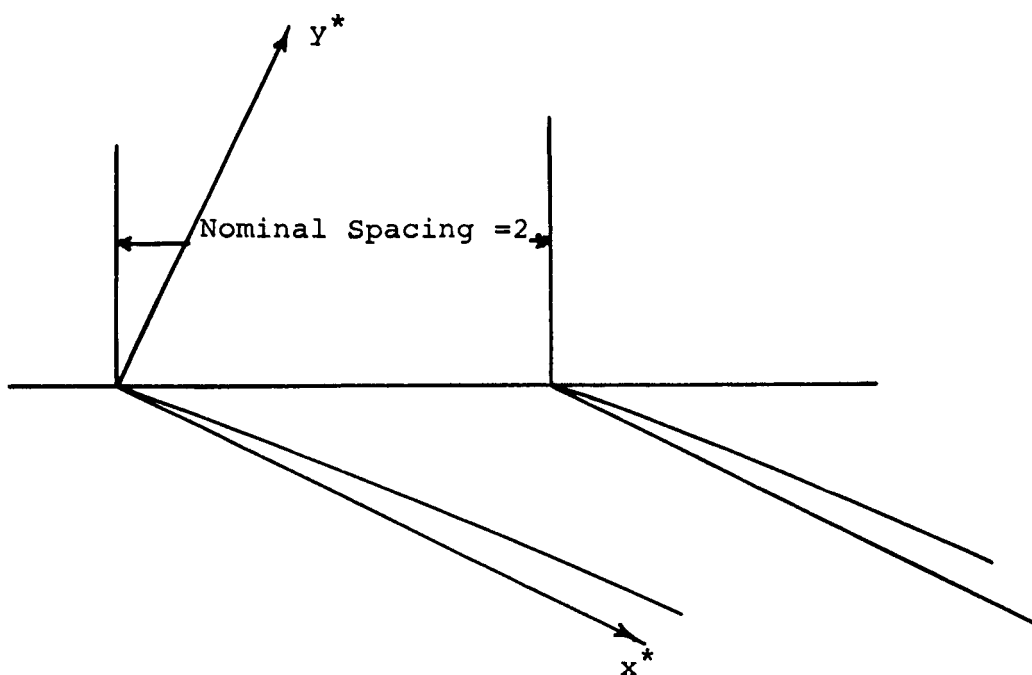


Figure 41. Coordinate System.

Table 1

Cascade Geometry and Tolerances

Mach number far upstream	1.4
incidence angle far upstream	72 degrees (measured from axial direction)
number of blades	38
nominal stagger angle	65 degrees (measured from axial direction)
tolerance in stagger	$\pm 3/4$ degrees
tolerance in blade spacing	$\pm 0.1\%$ of nominal spacing
nominal surface contour	*parabolic shape

$$* \quad \frac{2y^*}{s} = -0.555 \left(\frac{2x^*}{s} \right)^2 + 0.17633 \left(\frac{2x^*}{s} \right)$$

where x^* : taken along the line the angle of which measured
from the axial direction is equal to stagger angle
(see Fig. 40)

s: nominal spacing

BLADE SPACING ERRORS DISTRIBUTION

Table 2

Blade No.	A-1	A-2
1	+*	-
2	+	+
3	+	-
4	-	-
5	+	-
6	-	+
7	-	+
8	+	-
9	-	+
10	+	-
11	+	-
12	-	+
13	-	-
14	-	+
15	+	-
16	+	+
17	-	+
18	+	+
19	+	-
20	-	+
21	+	-
22	-	-
23	-	+
24	-	+
25	-	+
26	+	+
27	+	-
28	-	+
29	+	-
30	+	-
31	-	+
32	+	-
33	-	+
34	+	-
35	-	+
36	-	-
37	+	+
38	+	-

* + means + 0.1% error
 - means - 0.1% error

STAGGER ERRORS DISTRIBUTION

Table 3

Blade No.	B-1	B-2
1	+*	-
2	+	+
3	+	+
4	+	+
5	-	-
6	-	-
7	+	+
8	+	-
9	+	+
10	+	+
11	+	+
12	-	-
13	-	-
14	+	+
15	-	-
16	-	-
17	+	+
18	-	-
19	-	+
20	-	+
21	+	+
22	-	-
23	-	-
24	-	-
25	+	+
26	-	-
27	+	+
28	-	-
29	+	+
30	-	-
31	+	+
32	+	+
33	-	-
34	-	-
35	+	-
36	+	+
37	+	-
38	+	+

* + means + 0.75 degrees error
 -- means - 0.75 degrees error

TABLE 4
ACOUSTIC SUMMARY - LONG INLET

<u>BPF (KHz)</u>	<u>Mr</u>	<u>α (deg)</u>	<u>X/C</u>	<u>SPL/BPF</u> <u>db</u>	<u>ΔSPL*/MRF\neq</u> <u>db</u>	<u>ΔSPL/MRF</u> <u>db</u>	<u>SPL/MRF</u> <u>db</u>
13.25	1.094	5.9	0.61	155.9	-9.8/3	-1.2/20	154.7/20
			1.76	137.5	12.3/1	+13.1/19	150.6/19
			3.01	135.0	5.5/3	9.2/19	144.2/19
13	1.057	7.6	0.61	165.9	-16/1	-11.3/20	154.6/20
			1.76	140.3	17.1/1	4.9/19	145.2/19
			3.01	148.4*	-1.7/3	-7/19	144.4/19
13	1.0375	9.6	0.61	167.2	-18.7/3	-19.4/25	147.8/25
			1.76	152.4	5.4/1	-9.7/25	142.7/25
			3.01	146.9	-3.6/1	-9.7/19	137.2/19
14	1.157	5.4	0.61	152.5	-2.7/1	2.7/20	155.2/20
			1.76	136.4	22.3/1	13.6/20	150/20
			3.01	133.1	18.2/1	15.2/10	148.3/10
14	1.144	6.7	0.61	159.5	-8/3	-1.8/20	157.7/20
			1.76	136.4	29.8/1	18.8/12	155.2/19
			3.01	136.0	16.7/1	17.9/12	153.9/19
14	1.128	8.65	0.61	163.1	-11.6/3	-4.4/15	158.7/15
			1.76	138.2	26.9/1	13.9/19	152.1/19
			3.01	136.0	16.5/1	16.9/15	152.9/15
15.1	1.26	5.1	0.61	144.7	4.1/1	0.4/12	145/12
			1.76	131.0	27.5/1	14.6/11	145.6/11
			3.01	129.9	22.9/1	13.2/12	143.1/12
15.1	1.245	5.93	0.61	152.6	1.3/1	3.6/20	156.2/20
			1.76	134.0	33.1/1	18/20	152/20
			3.01	128.8	26.4/1	21.7/10	150.5/20
15.1	1.226	7.6	0.61	159.2	-6.6/1	-4.6/12	154.6/12
			1.76	141.8	24/1	9.9/12	151.7/12
			3.01	135.5	14.4/2	15.2/20	150.7/20

* Broadband noise high

\neq MRF - Multiples of rotor frequency

+ Δ SPL - Deviation from SPL at BPF

Table 5

Acoustic Summary - Plenum

BPF (KHz)	M_r	α (deg)	SPL/RF db	SPL/MRF* db	SPL/BPF db
13.25	1.094	5.9	129.3	109.7/19	103.7
13.	1.057	7.6	133.9	103.6/19	108.3
13.	1.0357	9.6	135.7	97.0/19	109.5
14.	1.157	5.4	131.3	122.9/13	97.5
14.	1.144	6.7	139.9	117.1/9	97.2
14.	1.128	8.65	141.1	113.9/14	101.6
15.1	1.26	5.1	135.7	128.0/16	95.9
15.1	1.245	5.93	136.0	123.8/10	95.5
15.1	1.226	7.6	131.5	124.3/10	95.8
13.	1.066	6.6	129.5	123.2/20	119.1
13.	1.053	8.0	130.8	121.5/15	121.8
13.	1.035	9.9	139.6	116.4/12	125.2
14.	1.148	6.2	143.8	133.2/20	113.9
14.	1.139	7.3	139.5	132.0/12	116.5
14.	1.129	8.4	146.9	131.3/15	123.3
15.1	1.239	6.4	141.6	119.9/21	108.7
15.1	1.233	6.9	144.3	127.8/10	106.7
15.1	1.222	8.1	148.1	129.3/10	109.6

Long Inlet

Short Inlet

* MRF - Multiples of rotor frequency.

Table 6

Input Data for MPT Computation of Experimental Rotor

Mach Number far upstream	1.25
incidence angle far upstream	63.8 degrees (measured from axial direction)
number of blades	40
nominal stagger angle	62 degrees (measured from axial direction)
errors in stagger	see Fig. 11
errors in blade spacing	see Fig. 11
nominal surface contour near the leading edge	* parabolic shape

$$* \quad \frac{2y^*}{s} = -0.04279 \left(\frac{2\pi^*}{s} \right)^2 + 0.06993 \left(\frac{2x^*}{s} \right)$$

Appendix 1. Description of Computer Program "MPT"

The main structure of this program is shown in Fig. 42 and a brief description is given below. In step 1, various options are provided so that examinations can be carried out on the effects of manufacturing errors in:

- (1) stagger angle,
- (2) blade shape near the leading edge, and
- (3) spacing.

The effects of each error can be investigated independently of other errors or can be examined along with others. As explained in the section 2.0, it is necessary for the subsequent computation to identify the positions of the uninterrupted Mach wave that are attached to the blades. This is done in step 2. In step 3 and 4, two expansion fan systems upstream and downstream of the bow shock are obtained. The trajectory of the bow shock interacted by the two expansion-fan systems is obtained in step 5. Pressure distribution at a given axial location as a function of peripheral distance is obtained in step 6. In the final step 7, the Fourier analysis of the pressure distribution is performed to determine the harmonic components.

Throughout the program, the unit length is taken to be half of nominal spacing. In addition to the main program, the following subroutines are needed to execute the program.

Subroutine	ISPRESS
"	INSLOP
"	SHOCK
"	PRAND
"	INPRAND
"	FOUCU
"	TANGEN
"	COORD
"	DMACH

The functions of these subroutines are as follows:

ISPRESS compute isentropic pressure ratio between two
 given Mach numbers.

INSLOP	given the tangent to the airfoil contour, compute the position.
SHOCK	given the upstream Mach number and wedge angle, compute the shock angle and downstream flow condition.
PRAND	given Mach number, compute Prandtl-Meyer function v .
INPRAN	given Prandtl-Meyer function, compute Mach number.
FOUCU	harmonic analyzer.
TANGEN	given the position on the airfoil, compute the tangent to the surface.
COORD	given the x coordinate of airfoil, compute y coordinate.
DMACH	given a point in expansion fan, compute Mach wave passing through it.

The following input data are necessary to execute the computation.

<u>INPUT</u>	<u>FORTRAN SYMBOL</u>
(1) Mach number far upstream	EMACH
(2) Far upstream flow angle, measured from axial direction, in degrees	THETA
(3) Number of blades	NB
(4) Number of Mach wave behind the unintercepted Mach wave (usually 90)	NS
(5) Maximum axial distance ahead of rotor as ratio to half of the nominal spacing	YMAX
(6) Number of segment from rotor to maximum axial distance	NSEG
(7) Number of coefficients of poly- nomial representing suction sur- face contour (see 15)	NPRO
(8) Number of coefficients of poly- nomial representing suction sur- face tangent versus coordinate (see 16)	NSLO

- (9) Number of points between shock and unintercepted Mach wave to obtain pressure profile (usually 10) MMM
- (10) Spacing option ISOP
 If 1, different spacing between blades
 If 2, identical spacing
- (11) Spacing between blades as ratio to half of the nominal spacing; in case of identical spacing, only first spacing is needed SPACG(I)
- (12) Stagger option ISTAGR
 If 1, different stagger angle
 If 2, identical stagger angle
- (13) Stagger angle, measured from axial direction, in degrees; in case of identical stagger, only first stagger angle is needed STAGR(I)
- (14) Suction surface option IBSURF
 If 1, different suction surface shape
 If 2, identical suction surface shape
- (15) Jth coefficients of polynomial representing blade shape of Ith blade, $C(I,J)$; $y^* = C(I,1) + C(I,2) x^{*---} + C(I,J) x^{*(J-1)}$ COEFF(I,J)
 (for x^* , y^* , see Fig. 41)
 In case of identical surface shape, only $C(1,J)$ is needed
- (16) Jth coefficients of polynomial representing tangent-coordinate relationship of Ith blade, $A(I,J)$; SCOEF(I,J)

$$x^* = A(I,1) + A(I,2) \frac{dy^*}{dx^*} + --- + A(I,J) (dy^*/dx^*)^{(j-1)}$$
 In case of identical surface shape, only $A(1,J)$ is needed

Throughout the program, the value of specific heat ratio, γ , is taken to be 1.4. In the case of problem involving a gas other than air, the value of γ , designated as GAMMA in the program, has to be changed accordingly.

Appendix 2 Listing of Program "MPT"

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EMACH=INLFT RELATIVE MACH NUMRER
THETA=INLFT VELOCITY ANGLE MEASURED FROM AXIS IN DEGREES
NB=NUMBER OF BLADES
NS=NUMBER OF POINTS ON BLADE DOWNSTREAM OF THE UNINTERCEPTED
    MACH WAVE
ISOP=SPACING OPTION
    IF 1, DIFFERENT SPACING
    IF 2, IDENTICAL SPACING
    IF IDENTICAL, ONLY FIRST SPACING, SPACING(1), IS NEEDED,
    SPACG(1)=SPACING BETWEEN THE BLADES, GIVEN AS RATIO TO CHORD
    ISTAGR=STAGGER OPTION
    IF 1, DIFFERENT STAGGER
    IF 2, IDENTICAL STAGGER
    IF IDENTICAL, ONLY FIRST STAGGER, STAGR(1), IS NEEDED
    STAGR(1)=STAGGER ANGLE, ANGLE BETWEEN MEAN CHORD + AXIAL
    DIRECTION, IN DEGREES
    TRSURF=PLANE SURFACE SHAPE OPTION
    IF 1, DIFFERENT SHAPE
    IF 2, IDENTICAL SHAPE
    IF IDENTICAL, ONLY THE COEFFICIENTS OF FIRST BLADE, COEFF(1,J)
    ARE NEEDED.
    NPRO=NUMBER OF COEFFICIENTS OF POLYNOMIAL REPRESENTING BLADE
    SHAPE
    WARNING= LARGER BY 1 THEN THE ORDER OF POLYNOMIAL
    COEFF(I,J)=J-TH POLYNOMIAL COEFFICIENTS OF I-TH BLADE,
        I=1,-----,NPRO
    WARNING= START WITH COEFF(I,1) INSTEAD OF COEFF(I,0)
    NSLO=NUMBER OF COEFFICIENTS OF POLYNOMIAL REPRESENTING XCHORD
    (DEPENDENT)-DY/DX(INDEPENDENT) RELATION
    WARNING= LARGER BY 1 THAN THE ORDER OF POLYNOMIAL
    SCOE(I,J)=J-TH POLYNOMIAL COEFFICIENTS OF ABOVE RELATION,
        J=1,-----,NSLO
    WARNING= START WITH SCOE(I,1) INSTEAD IF SCOE(I,0)
    YMAX=MAXIMUM DISTANCE AHEAD OF ROTOR IN AXIAL DIRECTION,
        GIVE AS RATIO OF CHORD
    NSEG=NUMBER OF DIVISION OF YMAX
    MMM=NUMBER OF POINTS BEHIND A SHOCK TO OBTAIN PRESSURE PROFILE

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38 COMMON SCOFF(62,10),COEFF(62,10),TP(62,62),TX(62,62),ABSC(62),
39 AX,Y,XNU,SLOP,XM,PR,BETA,USLOPE,PRS,N,NPRO,NSLO,NB,
40 BM(62),STAGR(62),SPACE(62)
41 DIMENSION SPACG(62),SLOPE(202),XMU(202),XMACH(202),PRN(62,102),
42 AAD(62,102),BD(62,102),MD(62),DSLOPF(202),SO(62),DELTA(62),
43 RRTA(202),SA(202),SB(202),SX(202),SY(202),XT(62),YT(62),
44 CUSLP(202),DELTA(202),TXO(62,10),XTP(62),YTP(62),
45 DTXUN(62),TXS(62),YC(202),YP(202),XPN(202),YXNU(202)
46
47 READ-IN PROCEDURE
48 PAI=3.14159265
49 CALL FLGFOF(5,IND)
50
51 10 READ (5,1) EMACH,THETA,NR,NS,YMAX,NSEG
52 IF (IND.EQ.1) STOP
53 PRINT 473,EMACH,THETA,NB
54 FORMAT (1H1,10X,16H REL. MACH NO. =,F4.1,16X,23H INLET VELOCITY AN
55 1GLE =F4.0,16X,16H NO. OF BLADES =I3)
56 THETA=THETA*2./360.*PAI
57 NNR=NR-1
58 PRINT 478,NS
59 FORMAT (60H0
60 1AVE =I4)
61 1 FORMAT (2F10.2,2I10,F10.3,I10)
62 PRINT 483,YMAX,NSEG
63 FORMAT (1H0,10X,25H MAXIMUM AXIAL DISTANCE =,F7.3,25X,37H NO. OF S
64 1EGMENTS IN AXIAL DIRECTION =I3)
65 READ (5,2) NPRO,NSLO,MMM
66 2 FORMAT (3I10)
67 READ (5,2) ISOP
68 PRINT 503,NPRO
69 FORMAT (67H0
70 1LADE SHAPE =I3)
71 GO TO (70,110),ISOP
72 READ (5,4) (SPACG(I),I=1,NB)
73 GO TO 160
74 110 READ (5,3) SPACG(1)
75 3 FORMAT (F10.3)
76 DO 150 I=1,NNB
77 SPACG(I+1)=SPACG(I)
78 CONTINUE
79 150

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77      160 READ (5,2) I,STAGR
78      PRINT 612
79      FORMAT (1H0,37X,43H J-TH COEFFICIENTS OF 1-TH BLADE POLYNOMIAL)
80      PRINT 615
81      FORMAT (120H COEFF(1,1) COEFF(1,2) COEFF(1,3) COEFF(1,4) COEFF
82      1F(1,5) COEFF(1,6) COEFF(1,7) COEFF(1,8) COEFF(1,9) COEFF(1,10)
83      2)
84      GO TO (1A0,230),I,STAGR
85      180 READ (5,4) (STAGR(I),I=1,NB)
86      DO 210 I=1,NB
87      STAGR(I)=STAGR(I)*2.*PAI/360.
88      CONTINUE
89      GO TO 280
90      230 READ (5,3) STAGR(1)
91      STAGR(1)=STAGR(1)*2.*PAI/360.
92      DO 270 I=1,NNQ
93      STAGR(I+1)=STAGR(I)
94      CONTINUE
95      280 READ (5,2) I,RSURF
96      GO TO (300,410),I,RSURF
97      DO 340 I=1,NR
98      READ (5,5) (COEFF(I,J),J=1,NPRO)
99      CONTINUE
100     DO 390 I=1,NR
101     READ (5,5) (SCOEFF(I,J),J=1,NSLO)
102     CONTINUE
103     GO TO 540
104     410 READ (5,5) (COEFF(1,J),J=1,NPRO)
105     DO 460 J=1,NPRO
106     DO 450 I=1,NNB
107     COEFF(I+1,J)=COEFF(1,J)
108     CONTINUE
109     460 CONTINUE
110     4 FORMAT (A610.4)
111     5 FORMAT (A610.4)
112     READ (5,5) (SCOEFF(1,J),J=1,NSLO)
113     DO 520 J=1,NSLO
114     DO 510 I=1,NNB
115     SCOEFF(I+1,J)=SCOEFF(1,J)

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116 CONTINUE
117 CONTINUE
118 DO 976 I=1,NB
119 PRINT 973,I
120 FORMAT (14H0
121 PRINT 975,(COEFF(I,J),J=1,NPRO)
122 FORMAT (1P10E12.4)
123 CONTINUE
124 PRINT 978,NSLO
125 FORMAT (78H0
126 1H0R0 = DY/DX RELATION =13)
127 PRINT 981
128 FORMAT (140,47X,51H J-TH COEFFICIENTS OF I-TH INVERSE - DY/DX RELA
129 TION)
130 PRINT 984
131 FORMAT (120H SCOFF(1,1) SCOFF(1,2) SCOFF(1,3) SCOFF(1,4) SCOF
132 F(1,5) SCOFF(1,6) SCOFF(1,7) SCOFF(1,8) SCOFF(1,9) SCOFF(1,10)
133 2)
134 DO 989 I=1,NB
135 PRINT 973,I
136 PRINT 975,(SCOFF(I,J),J=1,NSLO)
137 CONTINUE
138 PRINT 992,MMM
139 FORMAT (66H0
140 1MACH WAVE =13)
141 PRINT 995
142 FORMAT (140,19X,2H 1,20X,27H SPACING BETWEEN THE BLADES,13X,14H ST
143 AGGER ANGLE)
144 DO 1003 I=1,NB
145 DEG=STAGR(I)*180./PI
146 PRINT 1002,I,SPACG(I),DEG
147 FORMAT (122,1P1E36.4,F36.4)
148 CONTINUE
149 *** END OF READ-IN PROCEDURE
150 PRINT 1006
151 FORMAT (2X,////)
152 DO 1370 I=1,NB
153 *** UNINTERCEPTED MACH WAVE POSITION OF I-TH BLADE
154 SLOPE(1)=THETA-STAGR(I)

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155 SSS=TAN(SLOPE(1))
156 CALL INSLOP(1,SSS)
157 XC(1)=X
158 CALL CONRD(1,XC(1))
159 YC(1)=Y
160 XMU(1)=AR SIN(1./EMACH)
161 SPACF(1)=0.
162 XMACH(1)=EMACH
163 PRD(1,1)=1.
164 CALL PRAND(XMACH(1))
165 XXNU(1)=XXNU
166 ** MACH WAVE SYSTEMS BEHIND UNINTERCEPTED MACH WAVE
167 DO 910 J=1,NS
168 AD(1,J)=TAN(XMU(J)+SLOPF(J)+STAGR(1)-PAI/2.)
169 XP(J)=XC(J)+SIN(STAGR(1))+YC(J)+COS(STAGR(1))+SPACE(1)
170 YP(J)=YC(J)+COS(STAGR(1))+YC(J)+SIN(STAGR(1))
171 BD(1,J)=VP(J)-XP(J)*AN(1,J)
172 SPACF(1+1)=SPACF(1)+SPACG(1)
173 XCO=-BD(1,J)/AD(1,J)
174 IF (SPACF(1+1).GT.XCO) GO TO 790
175 MD(1)=J-1
176 MAD=MD(1)
177 GO TO 920
178 XC(J+1)=YC(J)+(SPACG(1)-XC(1))/FLOAT(NS)
179 CALL CONRD(1,XC(J+1))
180 YC(J+1)=Y
181 CALL TANGEN(1,XC(J+1))
182 SLOPF(J+1)=SLOP
183 DSLOPE(J)=SLOPF(J+1)+SLOPE(J)
184 XXNU(J+1)=XXNU(J)+DSLOPE(J)
185 CALL INPRAN(XXNU(J+1))
186 XMACH(J+1)=XM
187 XMU(J+1)=AR SIN(1./XMACH(J+1))
188 CALL ISPRES(XMACH(J+1),XMACH(1))
189 PRD(1,J+1)=PR
190 CONTINUE
191 K=1
192 STAGR(NR+1)=STAGR(1)
193 DO 1393 IAM=1,NPRO

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194 COEFF(NR+1,JAM)=COEFF(1,JAM)
195 CONTINUE
196 DO 1396 JAX=1,NSLO
197   COEFF(NR+1,JAX)=SCOEFF(1,JAX)
198 CONTINUE
199 ** INITIAL SHOCK ROUTINE
200   IPK=I+K
201   CALL TANGEN(IPK,0)
202   SC(IPK)=SLOP
203   DELTA(IPK)=SQ(IPK)+STAGR(IPK)-(SLOPE(MAD)+STAGR(I))
204   CALL SHOCK(XMACH(MAD),DELTA(IPK))
205   RTA(I)=RFTA
206   IF(RTA(I).LT.0.) GO TO 1850
207   SA(I)=TAN(SLOPE(MAD)+STAGR(I)+BTA(I))-PAI/2.)
208   SR(I)=-SA(I)+SPACE(J+1)
209   SX(I)=(RD(I,MAD)-SB(I))/(SA(I)-AD(I,MAD))
210   SY(I)=SY(I)+SA(I)+SR(I)
211 ** UNINTERCEPTED MACH WAVE BEHIND SHOCK ON I+1-TH BLADE
212   USLOP=THETA-STAGR(IPK)
213   SSS=TAN(USLOP)
214   CALL INSIOP(IPK,SSS)
215   XT(IPK)=Y
216   CALL CORPD(IPK,XT(IPK))
217   YT(IPK)=Y
218 ** SHOCK-EXPANSION WAVE INTERACTION
219   II=1
220   J=1
221   CALL DMACH(IPK,EMACH,THETA,YT(IPK),SX(J),SY(J))
222   USLP(J)=USLOPE
223   MDJJ=MD(I)-J
224   DDDELTA(I)=SLOPE(MDJJ)+STAGR(I)-(STAGR(IPK)+USLP(J))
225   DDDELTA(J)=-DDDELTA(J)
226   CALL SHOCK(XMACH(MDJJ),DDDELTA(J))
227   RTA(J+1)=BETA
228   SA(J+1)=TAN(SLOPE(MDJJ)+STAGR(I)+BTA(J+1))-PAI/2.)
229   SR(J+1)=SY(J)-SX(J)+SA(J+1)
230   SX(J+1)=(SR(J+1)-BD(I,MDJJ))/(AD(I,MDJJ)-SA(J+1))
231   SY(J+1)=SB(J+1)+SA(J+1)+SX(J+1)
232   GO TO 1250

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1240 J=J+1
      GO TO 1245
1250 YLIM=0.
      YLIM=YLIM+YMAX/FLOAT(NSEG)*FLOAT(I)
      IF (SY(J+1) .LE. YLIM) GO TO 1240
      IF (SY(J+1) .GT. YLIM) GO TO 1290
1290 TXO(IPK,I)=(SX(J+1)-SX(J))/(SY(J+1)-SY(J))*(YLIM-SY(J))+SX(J)
      IF (II.GF. NSEG) GO TO 1370
      II=II+1
      GO TO 1250
1370 CONTINUE
** CROSS SECTIONAL PRESSURE ROUTINE
      XT(NR+2)=XT(2)
      YT(NR+2)=YT(2)
      STAGR(NR+2)=STAGR(2)
      SPACE(NR+2)=SPACE(NR+1)+SPACG(1)
      MD11=MD(1)
      DO 1431 IJ=1,MD11
        AD(NR+1,IJ)=AD(1,IJ)
        BD(NR+1,IJ)=BD(1,IJ)-AD(1,IJ)*SPACE(NB+1)
        PRD(NR+1,IJ)=PRD(1,IJ)
1431 CONTINUE
      DO 1470 MJ=1,NSEG
        TXO(NR+2,MJ)=TXO(2,MJ)+SPACE(NB+1)
1470 CONTINUE
      DO 1440 I=1,NSEG
        PRINT 1993
1993 FORMAT (1H0,52X,15H SEGMENT NUMBER)
        PRINT 2022,J
2022 FORMAT (159)
        PRINT 2024
2024 FORMAT (1H0,25X,15H PROFILE NUMBER,10X,20H PERIPHERAL DISTANCE,10X
1,15H PRESSURE RATIO)
      YLIM=0.
      YLIM=YLIM+YMAX/FLOAT(NSEG)*FLOAT(J)
      CALL DMACH(2,EMACH,THETA,XT(2),TXO(2,J),YLIM)
      TP(1,1)=PRS
      TX(1,1)=0.
      JAS=1

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272 NASA=NB+1
273 DO 1803 I=1,NASA
274 XTP(I+1)=XT(I+1)*SIN(STAGR(I+1))+YT(I+1)*COS(STAGR(I+1))
275 A+SPACE(J+1)
276 YTP(I+1)=XT(I+1)*COS(STAGR(I+1))+YT(I+1)*SIN(STAGR(I+1))
277 ATP=TAN(YM(I+1))+THETA-PAY/2.)
278 TXUN(I+1)=(VLIIM-YTP(I+1))/ATP+XTP(I+1)
279 CONTINUE
280 HOW=TXO(2,J)+SPACE(NB+1)
281 IF (HOW .LT. TXUN(NR+2)) GO TO 2089
282 TP(I+1)=1.
283 PRINT 2187,JAS, TX(1,1),TP(1,1)
284 DO 1800 I=1,NB
285 IF (TXUN(I+1) .GT. TXO(I+1,J)) GO TO 2093
286 TXO(I+1,1)=TXUN(I+1)
287 IF (TXUN(I+2) .GT. TXO(I+2,J)) GO TO 2140
288 TXO(I+2,1)=TXUN(I+2)
289 FORMAT (17,F30.5,2F37.5)
290 DO 1660 JM=1,MMM
291 KK=I+1
292 TX(I,JM+1)=TX(I,1)+(TXUN(I+1)-TXO(I+1,J))*FLOAT(JM)/FLOAT(MMM)
293 TXS(I+1)=TXO(2,J)+TX(I,JM+1)
294 CALL DMACH(I+1,FMACH,THETA,XT(I+1),TXS(I+1),VLIIM)
295 TP(I,JM+1)=PRS
296 PRINT 2187,I,TX(I,JM+1),TP(I,JM+1)
297 FORMAT (135,2F29.5)
298 CONTINUE
299 DO 1730 JAK=2,NS
300 XL=(VLIIM-BD(I+1,JAK))/AD(I+1,JAK)
301 IF (XL .GT. TXO(I+2,J)) GO TO 1740
302 MJAK=MMM+JAK
303 TX(I,MJAK)=(VLIIM-BD(I+1,JAK))/AD(I+1,JAK)-TXO(2,J)
304 TP(I,MJAK)=PRD(I+1,JAK)
305 PRINT 2187,I,TX(I,MJAK),TP(I,MJAK)
306 CONTINUE
307 JAL=JAK-2
308 M(I)=MMM+JAL+2
309 M1=M(I)
310 TX(I,M1)=TXO(I+2,J)-TXO(2,J)

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311 TP(I,M1)=TP(I,M1-2)+(TX(I,M1)-TX(I,M1-2))*(TP(I,M1-1)-TP(I,M1-2))
312 1/(TX(I,M1-1)-TX(I,M1-2))
313 TX(I+1,1)=TX(I,M1)
314 CALL DMACH(I+2,FMACH,THETA,XT(I+2),TXO(I+2,J),VLIM)
315 TP(I+1,1)=PRS
316 PRINT 2187,1,TX(I,M1),TP(I,M1)
317 PRINT 2385,1,M(1)
318 PRINT 2387
319 PRINT 2100,KK,TXO(I+1,J),TXUN(I+1),VLIM
320 IF (1.EF. NR) GO TO 2321
321 PRINT 2024
322 PRINT 2187,KK,TX(I+1,1),TP(I+1,1)
323 CONTINUE
324 1800 SUM=N
325 DO 2324 IM=1,NR
326 SUM=SUM+SPACG(JIM)/FLOAT(NR)
327 CONTINUE
328 2324 DO 2330 JIS=1,NR
329 MILK=M(JIS)
330 DO 2329 IIN=1,MILK
331 TX(JIS,JIN)=TX(JIS,JIN)/SUM
332 CONTINUE
333 CONTINUE
334 PRINT 2389
335 DO 1831 N=1,NB
336 CALL FOURU
337 FORMAT (122,F40.8,F35.8)
338 1830 CONTINUE
339 DO 2359 N=1,NR
340 DDECTP=4.342945*ALOG(ARSC(N)/ARSC(NB))
341 PRINT 1830,N,ARSC(N),DDECTP
342 CONTINUE
343 CONTINUE
344 GO TO 2390
345 2359 PRINT 1860
346 FORMAT (11H0 SHOCK IS DETACHED)
347 1860 PRINT 1860
348 2385 FORMAT (11H0,10X,18H PROFILE NUMBER IS,13,15X,24H NUMBER OF DIVISIO
349 1NS ARE,14)
350 2387 FORMAT (11H0 BLADE NO.,15X,15H SHOCK POSITION,15X,28H UNINTERCEPT

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350      1D WAVE POSITION,15X,15H AXIAL DISTANCE)
351      2389  FORMAT (1H0,15X,10H HARMONICS,15X,31H SQUARE OF FOURIER COEFFICIENT
352      175,15X,9H DIFF. DB)
353      2390  GO TO 10
354      END

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23493 WORDS OF MEMORY USED BY THIS COMPILATION

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1      SUBROUTINE INPRAN(XNX)
2      COMMON SCDEF(62,10),COEFF(62,10),TS(62,62),TX(62,62),ABSC(62),
3      AX,Y,XNU,SLPP,XM,PR,RETA,USLOPE,PRS,N,APRO,USLO,PH,
4      RM(62),STAGR(62),SPACE(62)
5      AC=1.00064
6      A1=6.22919
7      A2=-178.313
8      A3=4145.15
9      A4=-59440.7
10     A5=538928
11     A6=-3.14714E+6
12     A7=1.17935E+7
13     A8=-2.737E+7
14     A9=3.57792E+7
15     A10=-20127598
16     XM=A7+A1*XNX+A2*YNX**2+A3*YNX**3+A4*YNX**4
17     A+A5*YNX**5+A6*YNX**6+A7*YNX**7+A8*YNX**8
18     R+A9*YNX**9+A10*YNX**10
19     RETURN
20     END

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1  SUBROUTINE SHOCK(XM1,DELT)
2  COMMON SCOFF(62,10),COEFF(62,10),IP(62,62),TX(62,62),ADSC(62),
3  AX,Y,XMU,SLUP,XM,PR,BETA,USLOPE,PRS,N,NPRO,NSLONG,
4  XM(62),STAR(62),SPACE(62)
5  DIMENSION DIFF(10),SE(10)
6  GAM=1.4
7  PAI=3.1415926535
8  BETA=PR*SI(1.0/XM1)
9  1730  DIF=2.*1./TAN(BETA)*(XM1**2*SIN(BETA)**2-1.)/(XM1**2*(GAM+
10  ACOS(2.*BETA)+2.))-TAN(DELT)
11  IF (DIF .GE. 0.) GO TO 1810
12  1770  BETA=BETA+1.0*PAI/180.
13  C=85.*PAI/180.
14  IF (BETA .GT. C) GO TO 2080
15  IF (BETA .LE. C) GO TO 1730
16  1810  SE(1)=BETA-1.*PAI/180.
17  SE(2)=BETA
18  DO 1860 I=1,2
19  DIFF(I)=2.*1./TAN(SE(I))*(XM1**2*SIN(SE(I))**2-1.)/(XM1**2*
20  A(GAM+COS(2.*SE(I))+2.))-TAN(DELT)
21  CONTINUE
22  SE(3)=SE(1)-(SE(2)-SE(1))/(DIFF(2)-DIFF(1))*DIFF(1)
23  DIFF(3)=2.*1./TAN(SE(3))*(XM1**2*SIN(SE(3))**2-1.)/(XM1**2*(GAM+
24  ACOS(2.*SE(3))+2.))-TAN(DELT)
25  IF (DIFF(3) .LE. 0.) GO TO 1990
26  SE(4)=SE(1)-(SE(3)-SE(1))/(DIFF(3)-DIFF(1))*DIFF(1)
27  DIFF(4)=2.*1./TAN(SE(4))*(XM1**2*SIN(SE(4))**2-1.)/(XM1**2*(GAM+
28  ACOS(2.*SE(4))+2.))-TAN(DELT)
29  IF (DIFF(4) .GT. 0.) GO TO 1970
30  IF (DIFF(4) .LE. 0.) GO TO 1990
31  1970  SE(5)=SE(1)-(SE(4)-SE(1))/(DIFF(4)-DIFF(1))*DIFF(1)

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32      GO TO 2990
33      BE(5)=BE(4)-(DE(3)-DE(4))/(DIFF(3)-DIFF(4))*DIFF(4)
34      GO TO 2990
35      BE(4)=BE(3)-(DE(2)-DE(3))/(DIFF(2)-DIFF(3))*DIFF(3)
36      DIFF(4)=2.*1./TAN(DE(4))*(XM1**2*SIN(DE(4))*2-1.)/(XM1**2*(GAM+
37      ACOS(2.*BE(4))+2.))-TAN(DELT)
38      IF (DIFF(4) .GT. 0.) GO TO 2040
39      IF (DIFF(4) .LT. 0.) GO TO 2030
40      DE(5)=DE(3)-(DE(4)-DE(3))/(DIFF(4)-DIFF(3))*DIFF(3)
41      GO TO 2990
42      DE(5)=DE(4)-(DE(2)-DE(4))/(DIFF(2)-DIFF(4))*DIFF(4)
43      BETA=BE(5)
44      GO TO 2090
45      BETA=-10.
46      XM2=1./SIN(BETA-DELT)*SORT((1.+(GAM-1.)/2.*XM1**2*SIN(BETA)
47      A**2)/(GAM*XM1**2*SIN(BETA)**2-(GAM-1.)/2.))
48      RETURN
49      END

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22975 WORDS OF MEMORY USED BY THIS COMPILATION

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1 SUBROUTINE PRAND(XMX)
2 COMMON SCOE(62,10),COEFF(62,10),TP(62,62),TX(62,62),ABSC(62),
3 AX,Y,XNU,SLOP,XM,PR,BETA,USLOPE,PRS,N,NPRO,NSLO,NB,
4 SM(62),STAGR(62),SPACE(62)
5 GAM=1.4
6 XR=(GAM+1.)/(GAM-1.)
7 XNU=SQRT(XR)*ATAN(SQRT(1./XR*(XMX**2-1.)))-ATAN(SQRT(XMX**2-1.))
8 RETURN
9 END

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22955 WORDS OF MEMORY USED BY THIS COMPILATION

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1 SUBROUTINE INSLOP(I,TANG)
2 COMMON SCOE(62,10),COEFF(62,10),TP(62,62),TX(62,62),ABSC(62),
3 AX,Y,XNU,SLOP,XM,PR,BETA,USLOPE,PRS,N,NPRO,NSLO,NB,
4 SM(62),STAGR(62),SPACE(62)
5 X=SCOE(I,1)
6 DO 5150 J=2,NSLO
7 X=X+SCOE(I,J)*TANG**(J-1)
8 5150 CONTINUE
9 RETURN
10 END

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23073 WORDS OF MEMORY USED BY THIS COMPILATION

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1  SUBROUTINE FOUCH
2  DIMENSION CR(100),CI(100),XP(100),XI(100),
3  AMM(62)
4  COMMON SPOFF(62,10),COEFF(62,10),TP(62,62),TX(62,62),ARSC(62),
5  AX,Y,XNU,SLOP,XM,PR,BETA,USLOPE,PRS,N,NPRO,NSLO,NH,
6  BM(62),STAGR(62),SPACE(62)
7  PAI=3.141592653
8  DO 70 I=1,NH
9  MM(I)=M(I)-1
10 CONTINUE
11 XX=0.
12 CCR=0.
13 CCI=0.
14 DO 260 J=1,NH
15 CR(I)=0.
16 CI(I)=0.
17 MMJ=MM(I)
18 DO 230 J=1,MMI
19 FNR=NR
20 FN=N
21 IF (TX(I,J+1) .LE. TX(I,J)) GO TO 3095
22 AIJ=(TP(I,J+1)-TP(I,J))/(TX(I,J+1)-TX(I,J))
23 HIJ=TP(I,J+1)-AIJ*TX(I,J+1)
24 CR(I)=CR(I)+1./FN*(AIJ*(TX(I,J+1)*SIN(FN*2.*PAI/FNR
25 A*TX(I,J+1))+FNR/(FN*2.*PAI)*COS(FN*2.*PAI/FNR*TX(I,J+1)))
26 R+RIJ*SIN(FN*2.*PAI/FNR*TX(I,J+1))
27 C-1./FN*(AIJ*(TX(I,J)*SIN(FN*2.*PAI/FNR
28 D*TX(I,J))+FNR/(FN*2.*PAI)*COS(FN*2.*PAI/FNR*TX(I,J)))
29 E+RIJ*SIN(FN*2.*PAI/FNR*TX(I,J))
30 CI(I)=CI(I)+1./FN*(AIJ*(-TX(I,J+1)*COS(FN*2.*PAI/FNR
31 A*TX(I,J+1))+FNR/(FN*2.*PAI)*SIN(FN*2.*PAI/FNR*

```

70

```

32      BTX(1,J+1)))
33      C=RIJ*COS(FN*2.*PAI/FN3*TX(1,J+1)))
34      D=1./FN*(AIJ*(-TX(1,J))*COS(FN*2.*PAI/FN3
35      E*TX(1,J))+FN3/(FN*2.*PAI)*SIN(FN*2.*PAI/FN3*TX(1,J)))
36      F=RIJ*COS(FN*2.*PAI/FN3*TX(1,J))
37      GO TO 230
38      3695 CR(1)=CR(1)
39      CI(1)=CI(1)
40      230      CONTINUE
41      CCR=CR(1)+CCR
42      CCI=CI(1)+CCI
43      260      CONTINUE
44      XP(N)=CCR
45      XI(N)=CCI
46      ABSC(N)=XR(N)**2+XI(N)**2
47      RETURN
48      END

```

22920 WORDS OF MEMORY USED BY THIS COMPILATION

```

1  SUBROUTINE ISPRF5(XM2,XXM1)
2  COMMON SCOE(62,10),COEFF(62,10),TP(62,62),TX(62,62),ABSC(62),
3  AX,Y,XNU,SLOP,XM,PR,BETA,USLOPE,PRS,N,NPRO,NSLO,NB,
4  SM(62),STAGR(62),SPACE(62)
5  GAM=1.4
6  PR=((1.+(GAM-1.)/2.*XM2**2)/(1.+(GAM-1.)/2.*XXM1**2))**((GAM/(GAM-
7  A1.))
8  PR=1./PR
9  RETURN
10 END

```

22951 WORDS OF MEMORY USED BY THIS COMPILATION

```

1  SUBROUTINE TANGEN(1,XXX)
2  COMMON SCOE(62,10),COEFF(62,10),TP(62,62),TX(62,62),ABSC(62),
3  AX,Y,XNU,SLOP,XM,PR,BETA,USLOPE,PRS,N,NPRO,NSLO,NB,
4  SM(62),STAGR(62),SPACE(62)
5  NPRO=NPRO-1
6  R=COEFF(1,2)
7  DO 5600 J=2,NPRO
8  R=R+FLOAT(J)*COEFF(1,J+1)*XXX**((J-1)
9  5600 CONTINUE
10 SLOP=ATAN(R)
11 RETURN
12 END

```

23020 WORDS OF MEMORY USED BY THIS COMPILATION

```

1  SUBROUTINE DMACH(I,EMACH,THETA,XTHET,XQ,YQ)
2  COMMON SCDEF(62,10),COEFF(62,10),TP(62,62),TX(62,62),ABSC(62),
3  AX,Y,XNU,SLOP,XM,PR,BETA,SLOPE,PRS,NANPRO,NSLC,NB,
4  BM(62),STAGR(62),SPACE(62)
5  DIMENSION XC(12),YC(12),XP(12),YP(12),SL(12),
6  AXNU(12),XM1(12),EP(12),PRON(12),
7  BTHET1(12),ANGLMA(12)
8  PAI=3.14159265
9
10  ** I SPECIFIES I-TH BLADE
11  ** EMACH IS MACH NUMBER AT INFINITY
12  ** THETA IS INLET VELOCITY ANGLE MEASURED FROM AXIS, IN DEGREE
13  ** XTHET IS THE POSITION ON AIRFOIL UPON WHICH UNINTERCEPTED MACH
14  ** WAVE IMPINGES, MEASURED IN AIRFOIL COORDINATE SYSTEM.
15  ** (XQ,YQ) IS THE POSITION OF THE POINT Q, MEASURED FROM THE ORIGIN.
16  ** THE MACH WAVE PASSING Q IS TO BE COMPUTED.
17  CALL PRAND(EMACH)
18  XNUO=XNU
19  XC(1)=0.
20  DO 540 J=1,10
21  CALL COORD(I,XC(J))
22  YC(J)=Y
23  XP(J)=XC(J)*SIN(STAGR(I))+YC(J)*COS(STAGR(I))+SPACE(I)
24  YP(J)=-XC(J)*COS(STAGR(I))+YC(J)*SIN(STAGR(I))
25  CALL TANGEN(I,XC(J))
26  SL(J)=SLOP
27  THET1(J)=SL(J)+STAGR(I)
28  XXNU(J)=XNUO+THETA-THET1(J)
29  CALL INPRAN(XXNU(J))
30  XM1(J)=XM
31  ANGLMA(J)=ARCSIN(1./XM1(J))
32  EP(J)=YC-YP(J)-TAN(ANGLMA(J)+THET1(J)-PAI/2.)*(XQ-XP(J))
33  XC(J+1)=XC(J)+XTHET/10.*FLOAT(J)
34  CALL COORD(I,XC(J+1))
35  YC(J+1)=Y
36  XP(J+1)=XC(J+1)*SIN(STAGR(I))+YC(J+1)*COS(STAGR(I))+SPACE(I)
37  YP(J+1)=-XC(J+1)*COS(STAGR(I))+YC(J+1)*SIN(STAGR(I))
38  CALL TANGEN(I,XC(J+1))

```



```

38 SL(J+1)=SLOP
39 THET1(J+1)=SL(J+1)+STAGR(I)
40 XXNU(J+1)=XNUO+THETA-THET1(J+1)
41 CALL INPRAN(XXNU(J+1))
42 XM1(J+1)=XM
43 ANGLMA(J+1)=ARSIN(1./XM1(J+1))
44 EP(J+1)=YQ-YP(J+1)-TAN(ANGLMA(J+1)+THET1(J+1)-PAI/2.)*(XQ-XP(J+1))
45 PROD(J)=EP(J)*EP(J+1)
46 IF (PROD(J) .GT. 0.) GO TO 540
47 K1=J
48 GO TO 550
49 CONTINUE
50 XC(1)=XC(K1)
51 K2=K1+1
52 XC(2)=XC(K2)
53 EP(1)=EP(K1)
54 EP(2)=EP(K2)
55 XC(3)=XC(1)-EP(1)*(XC(2)-XC(1))/(EP(2)-EP(1))
56 CALL COORD(1,XC(3))
57 YC(3)=Y
58 XP(3)=XC(3)*SIN(STAGR(1))+YC(3)*COS(STAGR(1))+SPACE(I)
59 YP(3)=-XC(3)*COS(STAGR(1))+YC(3)*SIN(STAGR(1))
60 CALL TANGEN(1,XC(3))
61 SL(3)=SLOP
62 THET1(3)=SL(3)+STAGR(1)
63 XXNU(3)=XNUO+THETA-THET1(3)
64 CALL INPRAN(XXNU(3))
65 XM1(3)=XM
66 ANGLMA(3)=ARSIN(1./XM1(3))
67 EP(3)=YQ-YP(3)-TAN(ANGLMA(3)+THET1(3)-PAI/2.)*(XQ-XP(3))
68 PROD(3)=EP(1)*EP(3)
69 IF (PROD(3) .LE. 0.) GO TO 780
70 XC(4)=XC(3)-EP(3)*(XC(2)-XC(3))/(EP(2)-EP(3))
71 GO TO 790
72 XC(4)=XC(1)-EP(1)*(XC(3)-XC(1))/(EP(3)-EP(1))
73 CALL COORD(1,XC(4))
74 YC(4)=Y
75 XP(4)=XC(4)*SIN(STAGR(1))+YC(4)*COS(STAGR(1))+SPACE(I)
76 YP(4)=-XC(4)*COS(STAGR(1))+YC(4)*SIN(STAGR(1))

```

```

77 CALL TANGEN(1,XC(4))
78 SL(4)=SLOP
79 THET1(4)=SL(4)+STAGR(1)
80 XGNU(4)=XNUO+THETA-THET1(4)
81 CALL INPRAN(XGNU(4))
82 XM1(4)=XM
83 ANGLMA(4)=ARSIN(1./XM1(4))
84 EP(4)=YC-YP(4)-TAN(ANGLMA(4)+THET1(4)-PA1/2.)*(XO-XP(4))
85 IF (PRON(3) .LE. 0.) GO TO 1000
86 PRON(4)=EP(3)*EP(4)
87 IF (PRON(4) .LE. 0.) GO TO 980
88 XC(5)=XC(4)-EP(4)*(XC(2)-XC(4))/(EP(2)-EP(4))
89 GO TO 1060
90 XC(5)=XC(3)-EP(3)*(XC(4)-XC(3))/(EP(4)-EP(3))
91 GO TO 1060
92 PRON(4)=EP(1)*EP(4)
93 IF (PRON(4) .LT. 0.) GO TO 1050
94 XC(5)=XC(4)-EP(4)*(XC(3)-XC(4))/(EP(3)-EP(4))
95 GO TO 1060
96 XC(5)=XC(1)-EP(1)*(XC(4)-XC(1))/(EP(4)-EP(1))
97 XCU=XCU(5)
98 CALL COORD(1,XCU)
99 YCU=Y
100 XPP=XCU*SIN(STAGR(1))+YCU*COS(STAGR(1))
101 YPP=-XCU*COS(STAGR(1))+YCU*SIN(STAGR(1))
102 CALL TANGEN(1,XCU)
103 USLOPE=SLOP
104 THES=USLOPE+STAGR(1)
105 XNUS=XNUO+THETA-THES
106 CALL INPRAN(XNUS)
107 UMACH=XM
108 CALL ISPRES(UMACH,EMACH)
109 PRS=PR
110 RETURN
111 END

```

23145 WORDS OF MEMORY USED BY THIS COMPILATION

```

1  SUBROUTINE COORD(I,XX)
2  COMMON SCOE(62,10),COEFF(62,10),TP(62,62),TX(62,62),ARSC(62),
3  AX,Y,XNU,SLOP,XM,PR,HETA,USLOPE,PRS,N,NPRQ,NSLO,NM,
4  BM(62),STAGR(62),SPACE(62)
5  Y=COEFF(I,1)
6  DO 6150 J=2,NPRQ
7  Y=Y+COEFF(I,J)*XX**(J-1)
8  6150 CONTINUE
9  RETURN
10 END

```

23073 WORDS OF MEMORY USED BY THIS COMPILATION

```

1  FUNCTION TAN(XYZ)
2  TAN= SIN(XYZ)/COS(XYZ)
3  RETURN
4  END

```

22787 WORDS OF MEMORY USED BY THIS COMPILATION

```

1  FUNCTION ARSIN(XYZ)
2  DEN=SQRT(1./XYZ**2-1.)
3  ARSIN=ATAN(1./DEN)
4  RETURN
5  END

```

22850 WORDS OF MEMORY USED BY THIS COMPILATION

Appendix 3. Sample Input and Output.

REL. MACH NO. = 1.4 INLET VELOCITY ANGLE = 72. NO. OF BLADES = 38
 NO. OF POINTS DOWNSTREAM OF UNINTERCEPTED MACH WAVE = 90
 MAXIMUM AXIAL DISTANCE = 10.000 NO. OF SEGMENTS IN AXIAL DIRECTION = 5
 J-TH COEFFICIENTS OF I-TH BLADE POLYNOMIAL
 COEFF(I,1) COEFF(I,2) COEFF(I,3) COEFF(I,4) COEFF(I,5) COEFF(I,6) COEFF(I,7) COEFF(I,8)

I = 1	1.7633E-01	-5.5500E-02					
I = 2	1.7633E-01	-5.5500E-02					
I = 3	1.7633E-01	-5.5500E-02					
I = 4	1.7633E-01	-5.5500E-02					
I = 5	1.7633E-01	-5.5500E-02					
I = 6	1.7633E-01	-5.5500E-02					
I = 7	1.7633E-01	-5.5500E-02					
I = 8	1.7633E-01	-5.5500E-02					
I = 9	1.7633E-01	-5.5500E-02					
I = 10	1.7633E-01	-5.5500E-02					
I = 11	1.7633E-01	-5.5500E-02					
I = 12	1.7633E-01	-5.5500E-02					
I = 13	1.7633E-01	-5.5500E-02					

0.	I = 14	1.7633E-01 -5.5500E-02
0.	I = 15	1.7633E-01 -5.5500E-02
0.	I = 16	1.7633E-01 -5.5500E-02
0.	I = 17	1.7633E-01 -5.5500E-02
	I = 18	
0.		1.7633E-01 -5.5500E-02
0.	I = 19	1.7633E-01 -5.5500E-02
0.	I = 20	1.7633E-01 -5.5500E-02
0.	I = 21	1.7633E-01 -5.5500E-02
0.	I = 22	1.7633E-01 -5.5500E-02
0.	I = 23	1.7633E-01 -5.5500E-02
0.	I = 24	1.7633E-01 -5.5500E-02
0.	I = 25	1.7633E-01 -5.5500E-02
0.	I = 26	1.7633E-01 -5.5500E-02
0.	I = 27	1.7633E-01 -5.5500E-02

0.	1 = 28	1.7633E-01 -5.5500E-02
0.	1 = 29	1.7633E-01 -5.5500E-02
0.	1 = 30	1.7633E-01 -5.5500E-02
0.	1 = 31	1.7633E-01 -5.5500E-02
0.	1 = 32	1.7633E-01 -5.5500E-02
0.	1 = 33	1.7633E-01 -5.5500E-02
0.	1 = 34	1.7633E-01 -5.5500E-02
0.	1 = 35	1.7633E-01 -5.5500E-02
0.	1 = 36	1.7633E-01 -5.5500E-02
0.	1 = 37	1.7633E-01 -5.5500E-02
	1 = 38	
0.		1.7633E-01 -5.5500E-02

NO. OF COEFFICIENTS OF POLYNOMIAL REPRESENTING CHORD - DY/DX RELATION = 2

J-TH COEFFICIENTS OF 1-TH INVERSE - DY/DX RELATION
SCOE(1.1) SCOE(1.2) SCOE(1.3) SCOE(1.4) SCOE(1.5) SCOE(1.6) SCOE(1.7) SCOE(1.8)

I = 1	1.5886E 00 -9.0090E 00
I = 2	1.5886E 00 -9.0090E 00
I = 3	1.5886E 00 -9.0090E 00
I = 4	1.5886E 00 -9.0090E 00
I = 5	1.5886E 00 -9.0090E 00
I = 6	1.5886E 00 -9.0090E 00
I = 7	1.5886E 00 -9.0090E 00
I = 8	1.5886E 00 -9.0090E 00
I = 9	1.5886E 00 -9.0090E 00
I = 10	1.5886E 00 -9.0090E 00
I = 11	1.5886E 00 -9.0090E 00
I = 12	1.5886E 00 -9.0090E 00
I = 13	1.5886E 00 -9.0090E 00
I = 14	1.5886E 00 -9.0090E 00

I = 15
1.5886E 00 -9.0090E 00

I = 16
1.5886E 00 -9.0090E 00

I = 17
1.5886E 00 -9.0090E 00

I = 18
1.5886E 00 -9.0090E 00

I = 19
1.5886E 00 -9.0090E 00

I = 20
1.5886E 00 -9.0090E 00

I = 21
1.5886E 00 -9.0090E 00

I = 22
1.5886E 00 -9.0090E 00

I = 23
1.5886E 00 -9.0090E 00

I = 24
1.5886E 00 -9.0090E 00

I = 25
1.5886E 00 -9.0090E 00

I = 26
1.5886E 00 -9.0090E 00

I = 27
1.5886E 00 -9.0090E 00

I = 28
1.5886E 00 -9.0090E 00

1 = 29
1.5886E 00 -9.0090E 00

1 = 30
1.5886E 00 -9.0090E 00

1 = 31
1.5886E 00 -9.0090E 00

1 = 32
1.5886E 00 -9.0090E 00

1 = 33
1.5886E 00 -9.0090E 00

1 = 34
1.5886E 00 -9.0090E 00

1 = 35
1.5886E 00 -9.0090E 00

1 = 36
1.5886E 00 -9.0090E 00

1 = 37
1.5886E 00 -9.0090E 00

1 = 38
1.5886E 00 -9.0090E 00

NO. OF POINTS BETWEEN A SHOCK AND UNINTERCEPTED MACH WAVE ■ 15	SPACING BETWEEN THE BLADES	STAGGER ANGLE
1	2.0020E 00	6.5000E 01
1	2.0020E 00	6.5000E 01
2	2.0020E 00	6.5000E 01
3	2.0020E 00	6.5000E 01
4	1.9980E 00	6.5000E 01
5	2.0020E 00	6.5000E 01
6	1.9980E 00	6.5000E 01
7	1.9980E 00	6.5000E 01
8	2.0020E 00	6.5000E 01
9	1.9980E 00	6.5000E 01
10	2.0020E 00	6.5000E 01
11	2.0020E 00	6.5000E 01
12	1.9980E 00	6.5000E 01
13	1.9980E 00	6.5000E 01
14	1.9980E 00	6.5000E 01
15	2.0020E 00	6.5000E 01
16	2.0020E 00	6.5000E 01
17	1.9980E 00	6.5000E 01
18	2.0020E 00	6.5000E 01
19	2.0020E 00	6.5000E 01
20	1.9980E 00	6.5000E 01
21	2.0020E 00	6.5000E 01
22	1.9980E 00	6.5000E 01
23	1.9980E 00	6.5000E 01
24	1.9980E 00	6.5000E 01
25	1.9980E 00	6.5000E 01
26	2.0020E 00	6.5000E 01
27	2.0020E 00	6.5000E 01
28	1.9980E 00	6.5000E 01
29	2.0020E 00	6.5000E 01
30	2.0020E 00	6.5000E 01
31	1.9980E 00	6.5000E 01
32	2.0020E 00	6.5000E 01
33	1.9980E 00	6.5000E 01
34	2.0020E 00	6.5000E 01
35	1.9980E 00	6.5000E 01
36	1.9980E 00	6.5000E 01
37	2.0020E 00	6.5000E 01
38	2.0020E 00	6.5000E 01

PROFILE NUMBER	SEGMENT NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
1	1	0.	1.05018
1		0.04274	1.04659
1		0.08548	1.04303
1		0.12822	1.03951
1		0.17095	1.03602
1		0.21369	1.03257
1		0.25643	1.02914
1		0.29917	1.02576
1		0.34191	1.02240
1		0.38465	1.01907
1		0.42739	1.01578
1		0.47013	1.01252
1		0.51286	1.00930
1		0.55560	1.00610
1		0.59834	1.00293
1		0.64108	0.99960
1		0.71482	0.99446
1		0.78776	0.98927
1		0.86156	0.98411
1		0.93623	0.97897
1		1.01181	0.97387
1		1.08630	0.96879
1		1.16574	0.96373
1		1.24414	0.95871
1		1.32352	0.95371
1		1.40392	0.94874
1		1.48536	0.94379
1		1.56787	0.93888
1		1.65147	0.93399
1		1.73620	0.92912
1		1.82209	0.92428
1		1.90918	0.91947
1		1.99750	0.91468
1		2.00200	0.91444

NUMBER OF DIVISIONS ARE 34

PROFILE NUMBER IS 1

BLADE NO.
2

SHOCK POSITION
5.92180

UNINTERCEPTED WAVE POSITION
6.56287

PROFILE NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
2	2.00200	1.05018
2	2.04474	1.04659
2	2.08748	1.04303
2	2.13022	1.03951
2	2.17295	1.03602
2	2.21569	1.03257
2	2.25843	1.02914
2	2.30117	1.02576
2	2.34391	1.02240
2	2.38665	1.01907
2	2.42939	1.01578
2	2.47213	1.01252
2	2.51486	1.00930
2	2.55760	1.00610
2	2.60034	1.00293
2	2.64308	0.99980
2	2.71682	0.99446
2	2.78976	0.98927
2	2.86356	0.98411
2	2.93823	0.97897
2	3.01381	0.97367
2	3.09030	0.96879
2	3.16774	0.96373
2	3.24614	0.95871
2	3.32552	0.95371
2	3.40592	0.94874
2	3.48736	0.94379
2	3.56987	0.93868
2	3.65347	0.93399
2	3.73820	0.92912
2	3.82409	0.92428
2	3.91118	0.91947
2	3.99950	0.91468
2	4.00400	0.91444

PROFILE NUMBER IS 2

NUMBER OF DIVISIONS ARE 34

BLADE NO.
3

SHOCK POSITION
7.92360

UNINTERCEPTED WAVE POSITION
8.56487

PROFILE NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
3	4.00400	1.05018
3	4.04674	1.04659
3	4.08948	1.04303
3	4.13222	1.03951
3	4.17495	1.03602
3	4.21769	1.03257
3	4.26043	1.02914
3	4.30317	1.02576
3	4.34591	1.02240
3	4.38865	1.01907
3	4.43139	1.01578
3	4.47413	1.01252
3	4.51686	1.00930
3	4.55960	1.00610
3	4.60234	1.00293
3	4.64508	0.99960
3	4.71863	0.99448
3	4.79137	0.98930
3	4.86497	0.98415
3	4.93944	0.97903
3	5.01441	0.97393
3	5.09109	0.96867
3	5.16830	0.96362
3	5.24648	0.95861
3	5.32563	0.95363
3	5.40579	0.94867
3	5.48699	0.94394
3	5.56924	0.93903
3	5.65259	0.93415
3	5.73706	0.92930
3	5.82268	0.92448
3	5.90949	0.91967
3	5.99752	0.91490
3	6.00020	0.91475

PROFILE NUMBER IS 3

NUMBER OF DIVISIONS ARE 34

BLADE NO. 4	SHOCK POSITION 9.92540	UNINTERCEPTED WAVE POSITION 10.56687	PERIPHERAL DISTANCE	PRESSURE RATIO
4	6.00020	1.05033	6.17163	1.03613
4	6.04396	1.04673	6.21449	1.03266
4	6.08591	1.04316	6.25735	1.02923
4	6.12877	1.03963	6.30021	1.02563
4			6.34307	1.02246
4			6.38593	1.01913
4			6.42879	1.01583
4			6.47164	1.01256
4			6.51450	1.00932
4			6.55736	1.00612
4			6.60022	1.00294
4			6.64308	0.99980
4			6.68594	0.99446
4			6.72876	0.98927
4			6.77162	0.98411
4			6.81449	0.97897
4			6.85735	0.97387
4			6.90021	0.96879
4			6.94307	0.96373
4			6.98593	0.95871
4			7.02879	0.95371
4			7.07164	0.94874
4			7.11450	0.94379
4			7.15736	0.93888
4			7.20021	0.93399
4			7.24307	0.92912
4			7.28593	0.92428
4			7.32879	0.91947
4			7.37164	0.91468
4			7.41450	0.91444

PROFILE NUMBER IS 4 NUMBER OF DIVISIONS ARE 34

BLADE NO.	SHOCK POSITION	UNINTERCEPTED WAVE POSITION	PERIPHERAL DISTANCE	PRESSURE RATIO
5	11.92199	12.56487		
	PROFILE NUMBER			
	5	8.00400	1.05018	
	5	8.04674	1.04659	
	5	8.08948	1.04303	
	5	8.13222	1.03951	
	5	8.17495	1.03632	
	5	8.21769	1.03257	
	5	8.26043	1.02914	
	5	8.30317	1.02576	
	5	8.34591	1.02240	
	5	8.38865	1.01937	
	5	8.43139	1.01578	
	5	8.47413	1.01252	
	5	8.51686	1.00930	
	5	8.55960	1.00610	
	5	8.60234	1.00233	
	5	8.64508	0.99930	
	5	8.68782	0.99448	
	5	8.73056	0.98930	
	5	8.77330	0.98415	
	5	8.81604	0.97933	
	5	8.85878	0.97333	
	5	8.90152	0.96837	
	5	8.94426	0.96332	
	5	9.00000		
	5	9.24648	0.95861	
	5	9.32563	0.95383	
	5	9.40579	0.94887	
	5	9.48699	0.94394	
	5	9.56924	0.93903	
	5	9.65259	0.93415	
	5	9.73706	0.92930	
	5	9.82268	0.92448	
	5	9.90949	0.91967	
	5	9.99752	0.91490	
	5	10.00020	0.91475	
PROFILE NUMBER IS 5		NUMBER OF DIVISIONS ARE 34		

BLADE NO.
6

SMOCK POSITION
13.92579

UNINTERCEPTED WAVE POSITION
14.56687

PROFILE NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
6	10.00020	1.05033
6	10.04306	1.04673
6	10.08591	1.04316
6	10.12877	1.03963
6	10.17163	1.03613
6	10.21449	1.03266
6	10.25735	1.02923
6	10.30021	1.02583
6	10.34307	1.02246
6	10.38593	1.01913
6	10.42879	1.01583
6	10.47164	1.01256
6	10.51450	1.00932
6	10.55736	1.00612
6	10.60022	1.00294
6	10.64308	0.99980
6	10.71663	0.99448
6	10.78937	0.98930
6	10.86297	0.98415
6	10.93744	0.97903
6	11.01281	0.97393
6	11.08909	0.96887
6	11.16530	0.96382
6	11.24448	0.95881
6	11.32363	0.95363
6	11.40379	0.94867
6	11.48499	0.94394
6	11.56724	0.93903
6	11.65059	0.93415
6	11.73506	0.92930
6	11.82068	0.92448
6	11.90749	0.91967
6	11.99552	0.91490
6	11.99820	0.91475

PROFILE NUMBER IS 6

NUMBER OF DIVISIONS ARE 34

BLADE NO. 7	SHOCK POSITION 15.92199	UNINTERCEPTED WAVE POSITION 16.56487	PERIPHERAL DISTANCE 11.99820	PRESSURE RATIO 1.05033
PROFILE NUMBER 7				
7	12.04105			1.04673
7	12.08391			1.04316
7	12.12677			1.03563
7	12.16963			1.03613
7	12.21249			1.03266
7	12.25535			1.02923
7	12.29821			1.02583
7	12.34107			1.02246
7	12.38393			1.01913
7	12.42679			1.01583
7	12.46964			1.01256
7	12.51250			1.00932
7	12.55536			1.00612
7	12.59822			1.00294
7	12.64108			0.99980
7	12.68394			0.99666
7	12.72679			0.99352
7	12.76964			0.99038
7	12.81250			0.98724
7	12.85536			0.98410
7	12.89822			0.98096
7	12.94107			0.97782
7	12.98393			0.97468
7	13.02679			0.97154
7	13.06964			0.96840
7	13.11250			0.96526
7	13.15536			0.96212
7	13.19822			0.95898
7	13.24107			0.95584
7	13.28393			0.95270
7	13.32679			0.94956
7	13.36964			0.94642
7	13.41250			0.94328
7	13.45536			0.94014
7	13.49822			0.93700
7	13.54107			0.93386
7	13.58393			0.93072
7	13.62679			0.92758
7	13.66964			0.92444
7	13.71250			0.92130
7	13.75536			0.91816
7	13.79822			0.91502
7	13.84107			0.91188
7	13.88393			0.90874
7	13.92679			0.90560
7	13.96964			0.90246
7	14.01250			0.89932

PROFILE NUMBER IS 7 NUMBER OF DIVISIONS ARE 34

BLADE NO. A	SHOCK POSITION 17.91999	UNINTERCEPTED WAVE POSITION 18.56287	PERIPHERAL DISTANCE	PRESSURE RATIO
A	14.00200	1.05018		
A	14.04474	1.04659		
A	14.08748	1.04303		
A	14.13022	1.03951		
A	14.17296	1.03602		
A	14.21569	1.03257		
A	14.25843	1.02914		
A	14.30117	1.02576		
A	14.34391	1.02240		
A	14.38665	1.01907		
A	14.42939	1.01578		
A	14.47213	1.01252		
A	14.51486	1.00930		
A	14.55760	1.00610		
A	14.60034	1.00293		
A	14.64308	0.99980		
A	14.71663	0.99448		
A	14.78937	0.98930		
A	14.86297	0.98415		
A	14.93744	0.97903		
A	15.01281	0.97393		
A	15.08909	0.96887		
A	15.16630	0.96382		
A	15.24448	0.95881		
A	15.32363	0.95383		
A	15.40379	0.94887		
A	15.48499	0.94394		
A	15.56724	0.93903		
A	15.65059	0.93415		
A	15.73506	0.92930		
A	15.82068	0.92448		
A	15.90749	0.91967		
A	15.99552	0.91490		
A	15.99820	0.91475		

PROFILE NUMBER IS 8

NUMBER OF DIVISIONS ARE 34

BLADE NO.	SHOCK POSITION	UNINTERCEPTED WAVE POSITION	PERIPHERAL DISTANCE	PRESSURE RATIO
9	19.92380	20.56487		
	PROFILE NUMBER			
	9	15.99620	1.05033	
	9	16.04106	1.04673	
	9	16.04391	1.04316	
	9	16.12677	1.03963	
	9	16.16963	1.03613	
	9	16.21249	1.03266	
	9	16.25535	1.02923	
	9	16.29821	1.02563	
	9	16.34107	1.02246	
	9	16.39393	1.01913	
	9	16.42679	1.01583	
	9	16.46964	1.01256	
	9	16.51250	1.00932	
	9	16.55536	1.00612	
	9	16.59822	1.00294	
	9	16.64108	0.99980	
	9	16.71482	0.99446	
	9	16.77776	0.98927	
	9	16.86156	0.98411	
	9	16.93623	0.97897	
	9	17.01181	0.97387	
	9	17.09630	0.96879	
	9	17.16574	0.96373	
	9	17.24414	0.95871	
	9	17.32352	0.95371	
	9	17.40392	0.94874	
	9	17.48536	0.94379	
	9	17.56787	0.93888	
	9	17.65147	0.93399	
	9	17.73620	0.92912	
	9	17.82209	0.92428	
	9	17.90918	0.91947	
	9	17.99750	0.91468	
	9	18.08200	0.91444	

NUMBER OF DIVISIONS ARE 34

PROFILE NUMBER IS 9

BLADE NO.
10

SHOCK POSITION
21.91999

UNINTERCEPTED WAVE POSITION
22.56287

PROFILE NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
10	18.00200	1.05018
10	18.04474	1.04559
10	18.08748	1.04303
10	18.13022	1.03951
10	18.17296	1.03602
10	18.21569	1.03257
10	18.25843	1.02914
10	18.30117	1.02576
10	18.34391	1.02240
10	18.38665	1.01907
10	18.42939	1.01578
10	18.47213	1.01252
10	18.51486	1.00930
10	18.55760	1.00610
10	18.60034	1.00293
10	18.64308	0.99960
10	18.68582	0.99646
10	18.72856	0.99327
10	18.77130	0.99011
10	18.81404	0.98697
10	18.85678	0.98383
10	18.89952	0.98069
10	18.94226	0.97755
10	18.98500	0.97441
10	19.02774	0.97127
10	19.07048	0.96813
10	19.11322	0.96499
10	19.15596	0.96185
10	19.19870	0.95871
10	19.24144	0.95557
10	19.28418	0.95243
10	19.32692	0.94929
10	19.36966	0.94615
10	19.41240	0.94301
10	19.45514	0.93987
10	19.49788	0.93673
10	19.54062	0.93359
10	19.58336	0.93045
10	19.62610	0.92731
10	19.66884	0.92417
10	19.71158	0.92103
10	19.75432	0.91789
10	19.79706	0.91475
10	19.83980	0.91161
10	19.88254	0.90847
10	19.92528	0.90533
10	19.96802	0.90219
10	20.01076	0.89905
10	20.05350	0.89591
10	20.09624	0.89277
10	20.13898	0.88963
10	20.18172	0.88649
10	20.22446	0.88335
10	20.26720	0.88021
10	20.30994	0.87707
10	20.35268	0.87393
10	20.39542	0.87079
10	20.43816	0.86765
10	20.48090	0.86451
10	20.52364	0.86137
10	20.56638	0.85823
10	20.60912	0.85509
10	20.65186	0.85195
10	20.69460	0.84881
10	20.73734	0.84567
10	20.78008	0.84253
10	20.82282	0.83939
10	20.86556	0.83625
10	20.90830	0.83311
10	20.95104	0.82997
10	20.99378	0.82683
10	21.03652	0.82369
10	21.07926	0.82055
10	21.12200	0.81741
10	21.16474	0.81427
10	21.20748	0.81113
10	21.25022	0.80799
10	21.29296	0.80485
10	21.33570	0.80171
10	21.37844	0.79857
10	21.42118	0.79543
10	21.46392	0.79229
10	21.50666	0.78915
10	21.54940	0.78601
10	21.59214	0.78287
10	21.63488	0.77973
10	21.67762	0.77659
10	21.72036	0.77345
10	21.76310	0.77031
10	21.80584	0.76717
10	21.84858	0.76403
10	21.89132	0.76089
10	21.93406	0.75775
10	21.97680	0.75461
10	22.01954	0.75147
10	22.06228	0.74833
10	22.10502	0.74519
10	22.14776	0.74205
10	22.19050	0.73891
10	22.23324	0.73577
10	22.27598	0.73263
10	22.31872	0.72949
10	22.36146	0.72635
10	22.40420	0.72321
10	22.44694	0.72007
10	22.48968	0.71693
10	22.53242	0.71379
10	22.57516	0.71065
10	22.61790	0.70751
10	22.66064	0.70437
10	22.70338	0.70123
10	22.74612	0.69809
10	22.78886	0.69495
10	22.83160	0.69181
10	22.87434	0.68867
10	22.91708	0.68553
10	22.95982	0.68239
10	23.00256	0.67925
10	23.04530	0.67611
10	23.08804	0.67297
10	23.13078	0.66983
10	23.17352	0.66669
10	23.21626	0.66355
10	23.25900	0.66041
10	23.30174	0.65727
10	23.34448	0.65413
10	23.38722	0.65099
10	23.42996	0.64785
10	23.47270	0.64471
10	23.51544	0.64157
10	23.55818	0.63843
10	23.60092	0.63529
10	23.64366	0.63215
10	23.68640	0.62901
10	23.72914	0.62587
10	23.77188	0.62273
10	23.81462	0.61959
10	23.85736	0.61645
10	23.89960	0.61331
10	23.94234	0.61017
10	23.98508	0.60703
10	24.02782	0.60389
10	24.07056	0.60075
10	24.11330	0.59761
10	24.15604	0.59447
10	24.19878	0.59133
10	24.24152	0.58819
10	24.28426	0.58505
10	24.32700	0.58191
10	24.36974	0.57877
10	24.41248	0.57563
10	24.45522	0.57249
10	24.49796	0.56935
10	24.54070	0.56621
10	24.58344	0.56307
10	24.62618	0.55993
10	24.66892	0.55679
10	24.71166	0.55365
10	24.75440	0.55051
10	24.79714	0.54737
10	24.83988	0.54423
10	24.88262	0.54109
10	24.92536	0.53795
10	24.96810	0.53481
10	25.01084	0.53167
10	25.05358	0.52853
10	25.09632	0.52539
10	25.13906	0.52225
10	25.18180	0.51911
10	25.22454	0.51597
10	25.26728	0.51283
10	25.31002	0.50969
10	25.35276	0.50655
10	25.39550	0.50341
10	25.43824	0.50027
10	25.48098	0.49713
10	25.52372	0.49399
10	25.56646	0.49085
10	25.60920	0.48771
10	25.65194	0.48457
10	25.69468	0.48143
10	25.73742	0.47829
10	25.78016	0.47515
10	25.82290	0.47201
10	25.86564	0.46887
10	25.90838	0.46573
10	25.95112	0.46259
10	25.99386	0.45945
10	26.03660	0.45631
10	26.07934	0.45317
10	26.12208	0.45003
10	26.16482	0.44689
10	26.20756	0.44375
10	26.25030	0.44061
10	26.29304	0.43747
10	26.33578	0.43433
10	26.37852	0.43119
10	26.42126	0.42805
10	26.46400	0.42491
10	26.50674	0.42177
10	26.54948	0.41863
10	26.59222	0.41549
10	26.63496	0.41235
10	26.67770	0.40921
10	26.72044	0.40607
10	26.76318	0.40293
10	26.80592	0.39979
10	26.84866	0.39665
10	26.89140	0.39351
10	26.93414	0.39037
10	26.97688	0.38723
10	27.01962	0.38409
10	27.06236	0.38095
10	27.10510	0.37781
10	27.14784	0.37467
10	27.19058	0.37153
10	27.23332	0.36839
10	27.27606	0.36525
10	27.31880	0.36211
10	27.36154	0.35897
10	27.40428	0.35583
10	27.44702	0.35269
10	27.48976	0.34955
10	27.53250	0.34641
10	27.57524	0.34327
10	27.61798	0.34013
10	27.66072	0.33699
10	27.70346	0.33385
10	27.74620	0.33071
10	27.78894	0.32757
10	27.83168	0.32443
10	27.87442	0.32129
10	27.91716	0.31815
10	27.95990	0.31501
10	28.00264	0.31187
10	28.04538	0.30873
10	28.08812	0.30559
10	28.13086	0.30245
10	28.17360	0.29931
10	28.21634	0.29617
10	28.25908	0.29303
10	28.30182	0.28989
10	28.34456	0.28675
10	28.38730	0.28361
10	28.43004	0.28047
10	28.47278	0.27733
10	28.51552	0.27419
10	28.55826	0.27105
10	28.60100	0.26791
10	28.64374	0.26477
10	28.68648	0.26163
10	28.72922	0.25849
10	28.77196	0.25535
10	28.81470	0.25221
10	28.85744	0.24907
10	28.90018	0.24593
10	28.94292	0.24279
10	28.98566	0.23965
10	29.02840	0.23651
10	29.07114	0.23337
10	29.11388	0.23023
10	29.15662	0.22709
10	29.19936	0.22395
10	29.24210	0.22081
10	29.28484	0.21767
10	29.32758	0.21453
10	29.37032	0.21139
10	29.41306	0.20825
10	29.45580	0.20511
10	29.49854	0.20197
10	29.54128	0.19883
10	29.58402	0.19569
10	29.62676	0.19255
10	29.66950	0.18941
10	29.71224	0.18627
10	29.75498	0.18313
10	29.79772	0.18000
10	29.84046	0.17686
10	29.88320	0.17372
10	29.92594	0.17058
10	29.96868	0.16744
10	30.01142	0.16430
10	30.05416	0.16116
10	30.09690	0.15802
10	30.13964	0.15488
10	30.18238	0.15174
10	30.22512	0.14860
10	30.26786	0.14546
10	30.31060	0.14232
10	30.35334	0.13918
10	30.39608	0.13604
10	30.43882	0.13290
10	30.48156	0.12976
10	30.52430	0.12662
10	30.56704	0.12348
10	30.60978	0.12034
10	30.65252	0.11720
10	30.69526	0.11406
10	30.73800	0.11092
10	30.78074	0.10778
10	30.82348	0.10464
10	30.86622	0.10150
10	30.90896	0.09836
10	30.95170	0.09522
10	30.99444	0.09208
10	31.03718	0.08894
10	31.07992	0.08580
10	31.12266	0.08266
10	31.16540	0.07952
10	31.20814	0.07638
10	31.25088	0.07324
10	31.29362	0.07010
10	31.33636	0.06696
10	31.37910	0.06382
10	31.42184	0.06068
10	31.46458	0.05754
10	31.50732	0.05440
10	31.55006	0.05126
10	31.59280	0.04812
10	31.63554	0.04498
10	31.67828	0.04184
10	31.72102	0.03870
10	31.76376	0.03556
10	31.80650	0.03242
10	31.84924	0.02928
10	31.89198	0.02614
10	31.93472	0.02300
10	31.97746	0

BLADE NO.	SHOCK POSITION 23.92380	UNINTERCEPTED WAVE POSITION 24.56487	PERIPHERAL DISTANCE	SSURE RATIO
11	11		20.00400	1.05018
	11		20.04674	1.04659
	11		20.08948	1.04303
	11		20.13222	1.03951
	11		20.17495	1.03602
	11		20.21769	1.03257
	11		20.26043	1.02914
	11		20.30317	1.02576
	11		20.34591	1.02240
	11		20.38865	1.01907
	11		20.43139	1.01578
	11		20.47413	1.01252
	11		20.51686	1.00930
	11		20.55960	1.00610
	11		20.60234	1.00293
	11		20.64508	0.99980
	11		20.71863	0.99448
	11		20.79137	0.98930
	11		20.86497	0.98415
	11		20.93944	0.97903
	11		21.01481	0.97393
	11		21.09109	0.96887
	11		21.16830	0.96382
	11		21.24648	0.95881
	11		21.32563	0.95383
	11		21.40579	0.94887
	11		21.48699	0.94394
	11		21.56924	0.93903
	11		21.65259	0.93415
	11		21.73706	0.92930
	11		21.82268	0.92448
	11		21.90949	0.91967
	11		21.99752	0.91490
	11		22.00020	0.91475

NUMBER OF DIVISIONS ARE 34

BLADE NO.
12

SHOCK POSITION
25.92580

UNINTERCEPTED WAVE POSITION
26.56687

PROFILE NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
12	22.00020	1.05033
12	22.04305	1.04673
12	22.08591	1.04316
12	22.12877	1.03963
12	22.17163	1.03613
12	22.21449	1.03266
12	22.25735	1.02923
12	22.30021	1.02583
12	22.34307	1.02246
12	22.38593	1.01913
12	22.42879	1.01563
12	22.47164	1.01256
12	22.51450	1.00932
12	22.55736	1.00612
12	22.60022	1.00294
12	22.64308	0.99980
12	22.68593	0.99648
12	22.72879	0.99330
12	22.77164	0.98990
12	22.81450	0.98645
12	22.85736	0.98293
12	22.90022	0.97939
12	22.94308	0.97587
12	22.98593	0.97232
12	23.02879	0.96881
12	23.07164	0.96533
12	23.11450	0.96187
12	23.15736	0.95839
12	23.20022	0.95494
12	23.24308	0.95150
12	23.28593	0.94803
12	23.32879	0.94459
12	23.37164	0.94115
12	23.41450	0.93771
12	23.45736	0.93426
12	23.50022	0.93081
12	23.54308	0.92736
12	23.58593	0.92391
12	23.62879	0.92046
12	23.67164	0.91701
12	23.71450	0.91356
12	23.75736	0.91011
12	23.80022	0.90666
12	23.84308	0.90321
12	23.88593	0.89976
12	23.92879	0.89631
12	23.97164	0.89286
12	24.01450	0.88941
12	24.05736	0.88596
12	24.10022	0.88251
12	24.14308	0.87906
12	24.18593	0.87561
12	24.22879	0.87216
12	24.27164	0.86871
12	24.31450	0.86526
12	24.35736	0.86181
12	24.40022	0.85836
12	24.44308	0.85491
12	24.48593	0.85146
12	24.52879	0.84801
12	24.57164	0.84456
12	24.61450	0.84111
12	24.65736	0.83766
12	24.70022	0.83421
12	24.74308	0.83076
12	24.78593	0.82731
12	24.82879	0.82386
12	24.87164	0.82041
12	24.91450	0.81696
12	24.95736	0.81351
12	25.00022	0.81006
12	25.04308	0.80661
12	25.08593	0.80316
12	25.12879	0.79971
12	25.17164	0.79626
12	25.21450	0.79281
12	25.25736	0.78936
12	25.30022	0.78591
12	25.34308	0.78246
12	25.38593	0.77901
12	25.42879	0.77556
12	25.47164	0.77211
12	25.51450	0.76866
12	25.55736	0.76521
12	25.60022	0.76176
12	25.64308	0.75831
12	25.68593	0.75486
12	25.72879	0.75141
12	25.77164	0.74796
12	25.81450	0.74451
12	25.85736	0.74106
12	25.90022	0.73761
12	25.94308	0.73416
12	25.98593	0.73071
12	26.02879	0.72726
12	26.07164	0.72381
12	26.11450	0.72036
12	26.15736	0.71691
12	26.20022	0.71346
12	26.24308	0.71001
12	26.28593	0.70656
12	26.32879	0.70311
12	26.37164	0.69966
12	26.41450	0.69621
12	26.45736	0.69276
12	26.50022	0.68931
12	26.54308	0.68586
12	26.58593	0.68241
12	26.62879	0.67896
12	26.67164	0.67551
12	26.71450	0.67206
12	26.75736	0.66861
12	26.80022	0.66516
12	26.84308	0.66171
12	26.88593	0.65826
12	26.92879	0.65481
12	26.97164	0.65136
12	27.01450	0.64791
12	27.05736	0.64446
12	27.10022	0.64101
12	27.14308	0.63756
12	27.18593	0.63411
12	27.22879	0.63066
12	27.27164	0.62721
12	27.31450	0.62376
12	27.35736	0.62031
12	27.40022	0.61686
12	27.44308	0.61341
12	27.48593	0.60996
12	27.52879	0.60651
12	27.57164	0.60306
12	27.61450	0.59961
12	27.65736	0.59616
12	27.70022	0.59271
12	27.74308	0.58926
12	27.78593	0.58581
12	27.82879	0.58236
12	27.87164	0.57891
12	27.91450	0.57546
12	27.95736	0.57201
12	28.00022	0.56856
12	28.04308	0.56511
12	28.08593	0.56166
12	28.12879	0.55821
12	28.17164	0.55476
12	28.21450	0.55131
12	28.25736	0.54786
12	28.30022	0.54441
12	28.34308	0.54096
12	28.38593	0.53751
12	28.42879	0.53406
12	28.47164	0.53061
12	28.51450	0.52716
12	28.55736	0.52371
12	28.60022	0.52026
12	28.64308	0.51681
12	28.68593	0.51336
12	28.72879	0.50991
12	28.77164	0.50646
12	28.81450	0.50301
12	28.85736	0.49956
12	28.90022	0.49611
12	28.94308	0.49266
12	28.98593	0.48921
12	29.02879	0.48576
12	29.07164	0.48231
12	29.11450	0.47886
12	29.15736	0.47541
12	29.20022	0.47196
12	29.24308	0.46851
12	29.28593	0.46506
12	29.32879	0.46161
12	29.37164	0.45816
12	29.41450	0.45471
12	29.45736	0.45126
12	29.50022	0.44781
12	29.54308	0.44436
12	29.58593	0.44091
12	29.62879	0.43746
12	29.67164	0.43401
12	29.71450	0.43056
12	29.75736	0.42711
12	29.80022	0.42366
12	29.84308	0.42021
12	29.88593	0.41676
12	29.92879	0.41331
12	29.97164	0.40986
12	30.01450	0.40641
12	30.05736	0.40296
12	30.10022	0.39951
12	30.14308	0.39606
12	30.18593	0.39261
12	30.22879	0.38916
12	30.27164	0.38571
12	30.31450	0.38226
12	30.35736	0.37881
12	30.40022	0.37536
12	30.44308	0.37191
12	30.48593	0.36846
12	30.52879	0.36501
12	30.57164	0.36156
12	30.61450	0.35811
12	30.65736	0.35466
12	30.70022	0.35121
12	30.74308	0.34776
12	30.78593	0.34431
12	30.82879	0.34086
12	30.87164	0.33741
12	30.91450	0.33396
12	30.95736	0.33051
12	31.00022	0.32706
12	31.04308	0.32361
12	31.08593	0.32016
12	31.12879	0.31671
12	31.17164	0.31326
12	31.21450	0.30981
12	31.25736	0.30636
12	31.30022	0.30291
12	31.34308	0.29946
12	31.38593	0.29601
12	31.42879	0.29256
12	31.47164	0.28911
12	31.51450	0.28566
12	31.55736	0.28221
12	31.60022	0.27876
12	31.64308	0.27531
12	31.68593	0.27186
12	31.72879	0.26841
12	31.77164	0.26496
12	31.81450	0.26151
12	31.85736	0.25806
12	31.90022	0.25461
12	31.94308	0.25116
12	31.98593	0.24771
12	32.02879	0.24426
12	32.07164	0.24081
12	32.11450	0.23736
12	32.15736	0.23391
12	32.20022	0.23046
12	32.24308	0.22701
12	32.28593	0.22356
12	32.32879	0.22011
12	32.37164	0.21666
12	32.41450	0.21321
12	32.45736	0.20976
12	32.50022	0.20631
12	32.54308	0.20286
12	32.58593	0.19941
12	32.62879	0.19596
12	32.67164	0.19251
12	32.71450	0.18906
12	32.75736	0.18561
12	32.80022	0.18216
12	32.84308	0.17871
12	32.88593	0.17526
12	32.92879	0.17181
12	32.97164	0.16836
12	33.01450	0.16491
12	33.05736	0.16146
12	33.10022	0.15801
12	33.14308	0.15456
12	33.18593	0.15111
12	33.22879	0.14766
12	33.27164	0.14421
12	33.31450	0.14076
12	33.35736	0.13731
12	33.40022	0.13386
12	33.44308	0.13041
12	33.48593	0.12696
12	33.52879	0.12351
12	33.57164	0.12006
12	33.61450	0.11661
12	33.65736	0.11316
12	33.70022	0.10971
12	33.74308	0.10626
12	33.78593	0.10281
12	33.82879	0.09936
12	33.87164	0.09591
12	33.91450	0.09246
12	33.95736	0.08901
12	34.00022	0.08556
12	34.04308	0.08211
12	34.08593	0.07866
12	34.12879	0.07521
12	34.17164	0.07176
12	34.21450	0.06831
12	34.25736	0.06486
12	34.30022	0.06141
12	34.34308	0.05796
12	34.38593	0.05451
12	34.42879	0.05106
12	34.47164	0.04761
12	34.51450	0.04416
12	34.55736	0.04071
12	34.60022	0.03726
12	34.64308	0.03381
12	34.68593	0.03036
12	34.72879	0.02691
12	34.77164	0.02346
12	34.81450	0.02001
12	34.85736	0.01656
12	34.90022	0.01311
12	34.94308	0.00966
12	34.98593	0.00621
12	35.02879	0.00276
12	35.07164	0.00000

PROFILE NUMBER IS 12

NUMBER OF DIVISIONS ARE 34

BLADE NO. 13	SHOCK POSITION 27.92199	UNINTERCEPTED WAVE POSITION 28.56487	PERIPHERAL DISTANCE	PRESSURE RATIO
13	23.99820		1.05033	
13	24.04105		1.04673	
13	24.08391		1.04316	
13	24.12677		1.03963	
13	24.16963		1.03613	
13	24.21249		1.03266	
13	24.25535		1.02923	
13	24.29821		1.02583	
13	24.34107		1.02246	
13	24.38393		1.01913	
13	24.42678		1.01583	
13	24.46964		1.01256	
13	24.51250		1.00932	
13	24.55536		1.00612	
13	24.59822		1.00294	
13	24.64108		0.99980	
13	24.68393		0.99668	
13	24.72678		0.99350	
13	24.76964		0.99032	
13	24.81250		0.98715	
13	24.85536		0.98393	
13	24.89822		0.98075	
13	24.94108		0.97758	
13	24.98393		0.97440	
13	25.02678		0.97122	
13	25.06964		0.96805	
13	25.11250		0.96487	
13	25.15536		0.96169	
13	25.19822		0.95852	
13	25.24108		0.95534	
13	25.28393		0.95216	
13	25.32678		0.94899	
13	25.36964		0.94581	
13	25.41250		0.94264	
13	25.45536		0.93946	
13	25.49822		0.93628	
13	25.54108		0.93310	
13	25.58393		0.92992	
13	25.62678		0.92675	
13	25.66964		0.92357	
13	25.71250		0.92039	
13	25.75536		0.91722	
13	25.79822		0.91404	
13	25.84108		0.91086	
13	25.88393		0.90769	
13	25.92678		0.90451	
13	25.96964		0.90134	
13	26.01250		0.89816	
13	26.05536		0.89498	
13	26.09822		0.89180	
13	26.14108		0.88863	
13	26.18393		0.88545	
13	26.22678		0.88227	
13	26.26964		0.87910	
13	26.31250		0.87592	
13	26.35536		0.87274	
13	26.39822		0.86957	
13	26.44108		0.86639	
13	26.48393		0.86321	
13	26.52678		0.86004	
13	26.56964		0.85686	
13	26.61250		0.85368	
13	26.65536		0.85050	
13	26.69822		0.84733	
13	26.74108		0.84415	
13	26.78393		0.84097	
13	26.82678		0.83780	
13	26.86964		0.83462	
13	26.91250		0.83144	
13	26.95536		0.82827	
13	26.99822		0.82509	
13	27.04108		0.82191	
13	27.08393		0.81874	
13	27.12678		0.81556	
13	27.16964		0.81238	
13	27.21250		0.80921	
13	27.25536		0.80603	
13	27.29822		0.80285	
13	27.34108		0.79968	
13	27.38393		0.79650	
13	27.42678		0.79332	
13	27.46964		0.79015	
13	27.51250		0.78697	
13	27.55536		0.78379	
13	27.59822		0.78062	
13	27.64108		0.77744	
13	27.68393		0.77426	
13	27.72678		0.77109	
13	27.76964		0.76791	
13	27.81250		0.76474	
13	27.85536		0.76156	
13	27.89822		0.75838	
13	27.94108		0.75521	
13	27.98393		0.75203	
13	28.02678		0.74885	
13	28.06964		0.74568	
13	28.11250		0.74250	
13	28.15536		0.73933	
13	28.19822		0.73615	
13	28.24108		0.73297	
13	28.28393		0.72980	
13	28.32678		0.72662	
13	28.36964		0.72344	
13	28.41250		0.72027	
13	28.45536		0.71709	
13	28.49822		0.71391	
13	28.54108		0.71074	
13	28.58393		0.70756	
13	28.62678		0.70438	
13	28.66964		0.70121	
13	28.71250		0.69803	
13	28.75536		0.69485	
13	28.79822		0.69168	
13	28.84108		0.68850	
13	28.88393		0.68533	
13	28.92678		0.68215	
13	28.96964		0.67897	
13	29.01250		0.67580	
13	29.05536		0.67262	
13	29.09822		0.66944	
13	29.14108		0.66627	
13	29.18393		0.66309	
13	29.22678		0.65991	
13	29.26964		0.65674	
13	29.31250		0.65356	
13	29.35536		0.65038	
13	29.39822		0.64721	
13	29.44108		0.64403	
13	29.48393		0.64085	
13	29.52678		0.63768	
13	29.56964		0.63450	
13	29.61250		0.63133	
13	29.65536		0.62815	
13	29.69822		0.62497	
13	29.74108		0.62180	
13	29.78393		0.61862	
13	29.82678		0.61544	
13	29.86964		0.61227	
13	29.91250		0.60909	
13	29.95536		0.60591	
13	30.00000		0.60274	

PROFILE NUMBER IS 13 NUMBER OF DIVISIONS ARE 34

BLADE NO.
14

SHOCK POSITION
29.91390

UNINTERCEPTED WAVE POSITION
30.56287

PROFILE NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
14	25.99620	1.05033
14	26.03905	1.04673
14	26.08191	1.04316
14	26.12477	1.03963
14	26.16763	1.03613
14	26.21049	1.03266
14	26.25335	1.02923
14	26.29621	1.02583
14	26.33907	1.02246
14	26.38193	1.01913
14	26.42478	1.01583
14	26.46764	1.01256
14	26.51050	1.00932
14	26.55336	1.00612

14	26.59622	1.00294
14	26.63908	0.99980
14	26.671282	0.99446
14	26.78576	0.98927
14	26.85956	0.98411
14	26.93423	0.97897
14	27.00981	0.97387
14	27.08630	0.96879
14	27.16374	0.96373
14	27.24214	0.95871
14	27.32152	0.95371
14	27.40192	0.94874
14	27.48336	0.94379
14	27.56567	0.93888
14	27.64947	0.93399
14	27.73420	0.92912
14	27.82009	0.92426
14	27.90718	0.91947
14	27.99550	0.91468
14	28.00000	0.91444

PROFILE NUMBER IS 14

NUMBER OF DIVISIONS ARE 34

BLADE NO. 15	SHOCK POSITION 31.91799	UNINTERCEPTED WAVE POSITION 32.56087
15	28.00000	1.05018
15	28.04274	1.04659
15	28.08548	1.04303
15	28.12822	1.03951
15	28.17096	1.03602
15	28.21369	1.03257
15	28.25643	1.02914
15	28.29917	1.02576
15	28.34191	1.02240
15	28.38465	1.01907
15	28.42739	1.01578
15	28.47013	1.01252
15	28.51286	1.00930
15	28.55560	1.00610
15	28.59834	1.00293
15	28.64108	0.99980
15	28.68382	0.99666
15	28.72656	0.99352
15	28.76930	0.99038
15	28.81204	0.98724
15	28.85478	0.98410
15	28.89752	0.98096
15	28.94026	0.97782
15	28.98300	0.97468
15	29.02574	0.97154
15	29.06848	0.96840
15	29.11122	0.96526
15	29.15396	0.96212
15	29.19670	0.95898
15	29.23944	0.95584
15	29.28218	0.95270
15	29.32492	0.94956
15	29.36766	0.94642
15	29.41040	0.94328
15	29.45314	0.94014
15	29.49588	0.93700
15	29.53862	0.93386
15	29.58136	0.93072
15	29.62410	0.92758
15	29.66684	0.92444
15	29.70958	0.92130
15	29.75232	0.91816
15	29.79506	0.91502
15	29.83780	0.91188
15	29.88054	0.90874
15	29.92328	0.90560
15	29.96602	0.90246
15	30.00876	0.89932
15	30.05150	0.89618
15	30.09424	0.89304
15	30.13698	0.88990
15	30.17972	0.88676
15	30.22246	0.88362
15	30.26520	0.88048
15	30.30794	0.87734
15	30.35068	0.87420
15	30.39342	0.87106
15	30.43616	0.86792
15	30.47890	0.86478
15	30.52164	0.86164
15	30.56438	0.85850
15	30.60712	0.85536
15	30.64986	0.85222
15	30.69260	0.84908
15	30.73534	0.84594
15	30.77808	0.84280
15	30.82082	0.83966
15	30.86356	0.83652
15	30.90630	0.83338
15	30.94904	0.83024
15	30.99178	0.82710
15	31.03452	0.82396
15	31.07726	0.82082
15	31.12000	0.81768
15	31.16274	0.81454
15	31.20548	0.81140
15	31.24822	0.80826
15	31.29096	0.80512
15	31.33370	0.80198
15	31.37644	0.79884
15	31.41918	0.79570
15	31.46192	0.79256
15	31.50466	0.78942
15	31.54740	0.78628
15	31.59014	0.78314
15	31.63288	0.78000
15	31.67562	0.77686
15	31.71836	0.77372
15	31.76110	0.77058
15	31.80384	0.76744
15	31.84658	0.76430
15	31.88932	0.76116
15	31.93206	0.75802
15	31.97480	0.75488
15	32.01754	0.75174
15	32.06028	0.74860
15	32.10302	0.74546
15	32.14576	0.74232
15	32.18850	0.73918
15	32.23124	0.73604
15	32.27398	0.73290
15	32.31672	0.72976
15	32.35946	0.72662
15	32.40220	0.72348
15	32.44494	0.72034
15	32.48768	0.71720
15	32.53042	0.71406
15	32.57316	0.71092
15	32.61590	0.70778
15	32.65864	0.70464
15	32.70138	0.70150
15	32.74412	0.69836
15	32.78686	0.69522
15	32.82960	0.69208
15	32.87234	0.68894
15	32.91508	0.68580
15	32.95782	0.68266
15	33.00056	0.67952
15	33.04330	0.67638
15	33.08604	0.67324
15	33.12878	0.67010
15	33.17152	0.66696
15	33.21426	0.66382
15	33.25700	0.66068
15	33.29974	0.65754
15	33.34248	0.65440
15	33.38522	0.65126
15	33.42796	0.64812
15	33.47070	0.64498
15	33.51344	0.64184
15	33.55618	0.63870
15	33.59892	0.63556
15	33.64166	0.63242
15	33.68440	0.62928
15	33.72714	0.62614
15	33.76988	0.62300
15	33.81262	0.61986
15	33.85536	0.61672
15	33.89810	0.61358
15	33.94084	0.61044
15	33.98358	0.60730
15	34.02632	0.60416
15	34.06906	0.60102
15	34.11180	0.59788
15	34.15454	0.59474
15	34.19728	0.59160
15	34.24002	0.58846
15	34.28276	0.58532
15	34.32550	0.58218
15	34.36824	0.57904
15	34.41098	0.57590
15	34.45372	0.57276
15	34.49646	0.56962
15	34.53920	0.56648
15	34.58194	0.56334
15	34.62468	0.56020
15	34.66742	0.55706
15	34.71016	0.55392
15	34.75290	0.55078
15	34.79564	0.54764
15	34.83838	0.54450
15	34.88112	0.54136
15	34.92386	0.53822
15	34.96660	0.53508
15	35.00934	0.53194
15	35.05208	0.52880
15	35.09482	0.52566
15	35.13756	0.52252
15	35.18030	0.51938
15	35.22304	0.51624
15	35.26578	0.51310
15	35.30852	0.50996
15	35.35126	0.50682
15	35.39400	0.50368
15	35.43674	0.50054
15	35.47948	0.49740
15	35.52222	0.49426
15	35.56496	0.49112
15	35.60770	0.48798
15	35.65044	0.48484
15	35.69318	0.48170
15	35.73592	0.47856
15	35.77866	0.47542
15	35.82140	0.47228
15	35.86414	0.46914
15	35.90688	0.46600
15	35.94962	0.46286
15	35.99236	0.45972
15	36.03510	0.45658
15	36.07784	0.45344
15	36.12058	0.45030
15	36.16332	0.44716
15	36.20606	0.44402
15	36.24880	0.44088
15	36.29154	0.43774
15	36.33428	0.43460
15	36.37702	0.43146
15	36.41976	0.42832
15	36.46250	0.42518
15	36.50524	0.42204
15	36.54798	0.41890
15	36.59072	0.41576
15	36.63346	0.41262
15	36.67620	0.40948
15	36.71894	0.40634
15	36.76168	0.40320
15	36.80442	0.40006
15	36.84716	0.39692
15	36.88990	0.39378
15	36.93264	0.39064
15	36.97538	0.38750
15	37.01812	0.38436
15	37.06086	0.38122
15	37.10360	0.37808
15	37.14634	0.37494
15	37.18908	0.37180
15	37.23182	0.36866
15	37.27456	0.36552
15	37.31730	0.36238
15	37.36004	0.35924
15	37.40278	0.35610
15	37.44552	0.35296
15	37.48826	0.34982
15	37.53100	0.34668
15	37.57374	0.34354
15	37.61648	0.34040
15	37.65922	0.33726
15	37.70196	0.33412
15	37.74470	0.33098
15	37.78744	0.32784
15	37.83018	0.32470
15	37.87292	0.32156
15	37.91566	0.31842
15	37.95840	0.31528
15	38.00114	0.31214
15	38.04388	0.30900
15	38.08662	0.30586
15	38.12936	0.30272
15	38.17210	0.29958
15	38.21484	0.29644
15	38.25758	0.29330
15	38.30032	0.29016
15	38.34306	0.28702
15	38.38580	0.28388
15	38.42854	0.28074
15	38.47128	0.27760
15	38.51402	0.27446
15	38.55676	0.27132
15	38.59950	0.26818
15	38.64224	0.26504
15	38.68498	0.26190
15	38.72772	0.25876
15	38.77046	0.25562
15	38.81320	0.25248
15	38.85594	0.24934
15	38.89868	0.24620
15	38.94142	0.24306
15	38.98416	0.23992
15	39.02690	0.23678
15	39.06964	0.23364
15	39.11238	0.23050
15	39.15512	0.22736
15	39.19786	0.22422
15	39.24060	0.22108
15	39.28334	0.21794
15	39.32608	0.21480
15	39.36882	0.21166
15	39.41156	0.20852
15	39.45430	0.20538
15	39.49704	0.20224
15	39.53978	0.19910
15	39.58252	0.19596
15	39.62526	0.19282
15	39.66800	0.18968
15	39.71074	0.18654
15	39.75348	0.18340
15	39.79622	0.18026
15	39.83896	0.17712
15	39.88170	0.17398
15	39.92444	0.17084
15	39.96718	0.16770
15	40.00992	0.16456
15	40.05266	0.16142
15	40.09540	0.15828
15	40.13814	0.15514
15	40.18088	0.15200
15	40.22362	0.14886
15	40.26636	0.14572
15	40.30910	0.14258
15	40.35184	0.13944
15	40.39458	0.13630
15	40.43732	0.13316
15	40.48	

BLADE NO. 16	SHOCK POSITION 33.92180	UNINTERCEPTED WAVE POSITION 34.56287	PERIPHERAL DISTANCE	PRESSURE RATIO
16	16		30.00200	1.005018
16	16		30.04474	1.004659
16	16		30.08748	1.004303
16	16		30.13022	1.003951
16	16		30.17296	1.003602
16	16		30.21569	1.003257
16	16		30.25843	1.002914
16	16		30.30117	1.002576
16	16		30.34391	1.002240
16	16		30.38665	1.001907
16	16		30.42939	1.001578
16	16		30.47213	1.001252
16	16		30.51486	1.000930
16	16		30.55760	1.000610
16	16		30.60034	1.000293
16	16		30.64308	0.999980
16	16		30.68582	0.999668
16	16		30.72856	0.999350
16	16		30.77130	0.999033
16	16		30.81404	0.998715
16	16		30.85678	0.998393
16	16		30.89952	0.998075
16	16		30.94226	0.997757
16	16		30.98500	0.997439
16	16		31.02774	0.997121
16	16		31.07048	0.996803
16	16		31.11322	0.996485
16	16		31.15596	0.996167
16	16		31.19870	0.995849
16	16		31.24144	0.995531
16	16		31.28418	0.995213
16	16		31.32692	0.994895
16	16		31.36966	0.994577
16	16		31.41240	0.994259
16	16		31.45514	0.993941
16	16		31.49788	0.993623
16	16		31.54062	0.993305
16	16		31.58336	0.992987
16	16		31.62610	0.992669
16	16		31.66884	0.992351
16	16		31.71158	0.992033
16	16		31.75432	0.991715
16	16		31.79706	0.991397
16	16		31.83980	0.991079
16	16		31.88254	0.990761
16	16		31.92528	0.990443
16	16		31.96802	0.990125

PROFILE NUMBER 18 16 NUMBER OF DIVISIONS ARE 34

BLADE NO.
17

SHOCK POSITION
35.92380

UNINTERCEPTED WAVE POSITION
36.56487

PROFILE NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
17	31.99820	1.05033
17	32.04109	1.04673
17	32.08391	1.04316
17	32.12677	1.03963
17	32.16963	1.03613
17	32.21249	1.03266
17	32.25535	1.02923
17	32.29821	1.02583
17	32.34107	1.02246
17	32.38393	1.01913
17	32.42679	1.01583
17	32.46964	1.01256
17	32.51250	1.00932
17	32.55536	1.00612
17	32.59822	1.00294
17	32.64108	0.99980
17	32.68394	0.99646
17	32.72676	0.99327
17	32.76963	0.99011
17	32.81250	0.98697
17	32.85536	0.98387
17	32.89822	0.98079
17	32.94108	0.97773
17	32.98394	0.97471
17	33.02676	0.97171
17	33.06963	0.96874
17	33.11250	0.96579
17	33.15536	0.96287
17	33.19822	0.95994
17	33.24108	0.95701
17	33.28394	0.95414
17	33.32676	0.95131
17	33.36963	0.94844
17	33.41250	0.94563
17	33.45536	0.94287
17	33.49822	0.94014
17	33.54108	0.93744
17	33.58394	0.93479
17	33.62676	0.93214
17	33.66963	0.92954
17	33.71250	0.92694
17	33.75536	0.92434
17	33.79822	0.92174
17	33.84108	0.91914
17	33.88394	0.91654
17	33.92676	0.91394
17	33.96963	0.91134
17	34.01250	0.90874

PROFILE NUMBER IS 17

NUMBER OF DIVISIONS ARE 34

BLADE NO.
18

SHOCK POSITION
37.91999

UNINTERCEPTED WAVE POSITION
38.56287

PROFILE NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
1A	34.00200	1.05018
1A	34.04474	1.04659
1A	34.08748	1.04303
1A	34.13022	1.03951
1A	34.17296	1.03602
1A	34.21569	1.03257
1A	34.25843	1.02914
1A	34.30117	1.02576
1A	34.34391	1.02240
1A	34.38665	1.01907
1A	34.42939	1.01578
1A	34.47213	1.01252
1A	34.51486	1.00930
1A	34.55760	1.00610
1A	34.60034	1.00293
1A	34.64308	0.99980
1A	34.68582	0.99666
1A	34.72856	0.99352
1A	34.77130	0.99041
1A	34.81404	0.98737
1A	34.85678	0.98437
1A	34.89952	0.98137
1A	34.94226	0.97837
1A	34.98500	0.97537
1A	35.02774	0.97237
1A	35.07048	0.96937
1A	35.11322	0.96637
1A	35.15596	0.96337
1A	35.19870	0.96037
1A	35.24144	0.95737
1A	35.28418	0.95437
1A	35.32692	0.95137
1A	35.36966	0.94837
1A	35.41240	0.94537
1A	35.45514	0.94237
1A	35.49788	0.93937
1A	35.54062	0.93637
1A	35.58336	0.93337
1A	35.62610	0.93037
1A	35.66884	0.92737
1A	35.71158	0.92437
1A	35.75432	0.92137
1A	35.79706	0.91837

0.92428
0.91947
0.91468
0.91444

35.42409
35.91118
35.39950
36.00400

PROFILE NUMBER IS 18

NUMBER OF DIVISIONS ARE 34

BLADE NO. 19	SHOCK POSITION 39.92360	UNINTERCEPTED WAVE POSITION 40.56487	PERIPHERAL DISTANCE	PRESSURE RATIO
19	36.00400	1.03018		
19	36.04674	1.04659		
19	36.08948	1.04303		
19	36.13222	1.03951		
19	36.17496	1.03602		
19	36.21769	1.03297		
19	36.26043	1.02914		
19	36.30317	1.02576		
19	36.34591	1.02240		
19	36.38865	1.01907		
19	36.43139	1.01578		
19	36.47413	1.01252		
19	36.51686	1.00930		
19	36.55960	1.00610		
19	36.60234	1.00293		
19	36.64508	0.99980		
19	36.68782	0.99668		
19	36.73056	0.99356		
19	36.77330	0.99044		
19	36.81604	0.98732		
19	36.85878	0.98420		
19	36.90152	0.98108		
19	36.94426	0.97796		
19	36.98700	0.97484		
19	37.02974	0.97172		
19	37.07248	0.96860		
19	37.11522	0.96548		
19	37.15796	0.96236		
19	37.20070	0.95924		
19	37.24344	0.95612		
19	37.28618	0.95300		
19	37.32892	0.94988		
19	37.37166	0.94676		
19	37.41440	0.94364		
19	37.45714	0.94052		
19	37.50000	0.93740		
19	37.54274	0.93428		
19	37.58548	0.93116		
19	37.62822	0.92804		
19	37.67096	0.92492		
19	37.71370	0.92180		
19	37.75644	0.91868		
19	37.79918	0.91556		
19	37.84192	0.91244		
19	37.88466	0.90932		
19	37.92740	0.90620		
19	37.97014	0.90308		
19	38.01288	0.90000		

PROFILE NUMBER IS 19 NUMBER OF DIVISIONS ARE 34

BLADE NO.	SHOCK POSITION	UNINTERCEPTED WAVE POSITION	PERIPHERAL DISTANCE	PRESSURE RATIO
20	41.92580	42.56687		
	PROFILE NUMBER			
	20		38.00020	1.05033
	20		38.04306	1.04673
	20		38.08591	1.04316
	20		38.12877	1.03963
	20		38.17163	1.03613
	20		38.21449	1.03266
	20		38.25735	1.02923
	20		38.30021	1.02563
	20		38.34307	1.02246
	20		38.38593	1.01913
	20		38.42879	1.01583
	20		38.47164	1.01256
	20		38.51450	1.00932
	20		38.55736	1.00612
	20		38.60022	1.00294
	20		38.64308	0.99980
	20		38.68594	0.99666
	20		38.72876	0.99352
	20		38.77162	0.99038
	20		38.81448	0.98724
	20		38.85734	0.98410
	20		38.90020	0.98096
	20		38.94306	0.97782
	20		38.98592	0.97468
	20		39.02878	0.97154
	20		39.07164	0.96840
	20		39.11450	0.96526
	20		39.15736	0.96212
	20		39.20022	0.95898
	20		39.24308	0.95584
	20		39.28594	0.95270
	20		39.32880	0.94956
	20		39.37166	0.94642
	20		39.41452	0.94328
	20		39.45738	0.94014
	20		39.50024	0.93700
	20		39.54310	0.93386
	20		39.58596	0.93072
	20		39.62882	0.92758
	20		39.67168	0.92444
	20		39.71454	0.92130
	20		39.75740	0.91816
	20		39.80026	0.91502
	20		39.84312	0.91188
	20		39.88598	0.90874
	20		39.92884	0.90560
	20		39.97170	0.90246
	20		40.01456	0.89932

NUMBER OF DIVISIONS ARE 34

PROFILE NUMBER IS 20

BLADE NO.
21

SHOCK POSITION
43.92199

UNINTERCEPTED WAVE POSITION
44.56487

PROFILE NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
21	40.00400	1.05018
21	40.04674	1.04659
21	40.08948	1.04303
21	40.13222	1.03951
21	40.17495	1.03602
21	40.21769	1.03257
21	40.26043	1.02914
21	40.30317	1.02576
21	40.34591	1.02240
21	40.38865	1.01907
21	40.43139	1.01578
21	40.47413	1.01252
21	40.51686	1.00930
21	40.55960	1.00610
21	40.60234	1.00293
21	40.64508	0.99980
21	40.68783	0.99648
21	40.73057	0.99330
21	40.77331	0.99015
21	40.81605	0.98703
21	40.85879	0.98393
21	40.90153	0.98087
21	40.94427	0.97782
21	40.98701	0.97481
21	41.02975	0.97183
21	41.07249	0.96887
21	41.11523	0.96593
21	41.15797	0.96303
21	41.20071	0.96013
21	41.24345	0.95723
21	41.28619	0.95433
21	41.32893	0.95143
21	41.37167	0.94853
21	41.41441	0.94563
21	41.45715	0.94273
21	41.50000	0.93983

21	41.56924	0.93903
21	41.65259	0.93415
21	41.73706	0.92930
21	41.82268	0.92446
21	41.90949	0.91967
21	41.99752	0.91490
21	42.00020	0.91475

PROFILE NUMBER IS 21

NUMBER OF DIVISIONS ARE 34

BLADE NO.	SHOCK POSITION	UNINTERCEPTED WAVE POSITION	PERIPHERAL DISTANCE	PRESSURE RATIO
22	45.92580	46.56667		
22	22		42.00020	1.03033
22	22		42.04306	1.04673
22	22		42.08592	1.04316
22	22		42.12877	1.03963
22	22		42.17163	1.03613
22	22		42.21449	1.03266
22	22		42.25735	1.02923
22	22		42.30021	1.02583
22	22		42.34307	1.02246
22	22		42.38593	1.01913
22	22		42.42879	1.01583
22	22		42.47164	1.01256
22	22		42.51450	1.00932
22	22		42.55736	1.00612
22	22		42.60022	1.00294
22	22		42.64308	0.99980
22	22		42.68593	0.99668
22	22		42.72879	0.99356
22	22		42.77164	0.99044
22	22		42.81450	0.98732
22	22		42.85736	0.98420
22	22		42.90022	0.98108
22	22		42.94308	0.97796
22	22		42.98593	0.97484
22	22		43.02879	0.97172
22	22		43.07164	0.96860
22	22		43.11450	0.96548
22	22		43.15736	0.96236
22	22		43.20022	0.95924
22	22		43.24308	0.95612
22	22		43.28593	0.95300
22	22		43.32879	0.94988
22	22		43.37164	0.94676
22	22		43.41450	0.94364
22	22		43.45736	0.94052
22	22		43.50022	0.93740
22	22		43.54308	0.93428
22	22		43.58593	0.93116
22	22		43.62879	0.92804
22	22		43.67164	0.92492
22	22		43.71450	0.92180
22	22		43.75736	0.91868
22	22		43.80022	0.91556
22	22		43.84308	0.91244
22	22		43.88593	0.90932
22	22		43.92879	0.90620
22	22		43.97164	0.90308
22	22		44.01450	0.90000

PROFILE NUMBER IS 22 NUMBER OF DIVISIONS ARE 34

BLADE NO.
23

SHOCK POSITION
47.92199

UNINTERCEPTED WAVE POSITION
48.56487

PROFILE NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
23	43.99820	1.05033
23	44.04106	1.04673
23	44.08392	1.04316
23	44.12677	1.03963
23	44.16963	1.03613
23	44.21249	1.03266
23	44.25535	1.02923
23	44.29821	1.02583
23	44.34107	1.02246
23	44.38393	1.01913
23	44.42679	1.01583
23	44.46965	1.01256
23	44.51250	1.00932
23	44.55536	1.00612
23	44.59822	1.00294
23	44.64108	0.99980
23	44.68393	0.99648
23	44.72679	0.99330
23	44.76965	0.98915
23	44.81250	0.98415
23	44.85536	0.97903
23	44.89822	0.97393
23	44.94108	0.96887
23	44.98393	0.96382
23	45.02679	0.95881
23	45.06965	0.95383
23	45.11250	0.94887
23	45.15536	0.94394
23	45.19822	0.93903
23	45.24108	0.93415
23	45.28393	0.92930
23	45.32679	0.92448
23	45.36965	0.91967
23	45.41250	0.91490
23	45.45536	0.91015
23	45.49822	0.90540
23	45.54108	0.90065
23	45.58393	0.89590
23	45.62679	0.89115
23	45.66965	0.88640
23	45.71250	0.88165
23	45.75536	0.87690
23	45.79822	0.87215
23	45.84108	0.86740
23	45.88393	0.86265
23	45.92679	0.85790
23	45.96965	0.85315
23	46.01250	0.84840
23	46.05536	0.84365
23	46.09822	0.83890
23	46.14108	0.83415
23	46.18393	0.82940
23	46.22679	0.82465
23	46.26965	0.81990
23	46.31250	0.81515
23	46.35536	0.81040
23	46.39822	0.80565
23	46.44108	0.80090
23	46.48393	0.79615
23	46.52679	0.79140
23	46.56965	0.78665
23	46.61250	0.78190
23	46.65536	0.77715
23	46.69822	0.77240
23	46.74108	0.76765
23	46.78393	0.76290
23	46.82679	0.75815
23	46.86965	0.75340
23	46.91250	0.74865
23	46.95536	0.74390
23	47.00000	0.73915

PROFILE NUMBER IS 23 NUMBER OF DIVISIONS ARE 34

BLADE NO.
24SMOCK POSITION
49.91999UNINTERCEPTED WAVE POSITION
50.56287

PROFILE NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
24	45.99620	1.05033
24	46.03906	1.04673
24	46.08192	1.04316
24	46.12477	1.03963
24	46.16763	1.03613
24	46.21049	1.03266
24	46.25335	1.02923
24	46.29621	1.02583
24	46.33907	1.02246
24	46.38193	1.01913
24	46.42479	1.01583
24	46.46764	1.01256
24	46.51050	1.00932
24	46.55336	1.00612
24	46.59622	1.00294
24	46.63908	0.99980
24	46.68193	0.99648
24	46.72479	0.99330
24	46.76764	0.98945
24	46.81050	0.98615
24	46.85336	0.98293
24	46.89622	0.97973
24	46.93907	0.97653
24	46.98193	0.97333
24	47.02479	0.97013
24	47.06764	0.96693
24	47.11050	0.96373
24	47.15336	0.96053
24	47.19622	0.95733
24	47.23907	0.95413
24	47.28193	0.95093
24	47.32479	0.94773
24	47.36764	0.94453
24	47.41050	0.94133
24	47.45336	0.93813
24	47.49622	0.93493
24	47.53907	0.93173
24	47.58193	0.92853
24	47.62479	0.92533
24	47.66764	0.92213
24	47.71050	0.91893
24	47.75336	0.91573
24	47.79622	0.91253
24	47.83907	0.90933
24	47.88193	0.90613
24	47.92479	0.90293
24	47.96764	0.89973
24	48.01050	0.89653
24	48.05336	0.89333
24	48.09622	0.89013
24	48.13907	0.88693
24	48.18193	0.88373
24	48.22479	0.88053
24	48.26764	0.87733
24	48.31050	0.87413
24	48.35336	0.87093
24	48.39622	0.86773
24	48.43907	0.86453
24	48.48193	0.86133
24	48.52479	0.85813
24	48.56764	0.85493
24	48.61050	0.85173
24	48.65336	0.84853
24	48.69622	0.84533
24	48.73907	0.84213
24	48.78193	0.83893
24	48.82479	0.83573
24	48.86764	0.83253
24	48.91050	0.82933
24	48.95336	0.82613
24	48.99622	0.82293
24	49.03907	0.81973
24	49.08193	0.81653
24	49.12479	0.81333
24	49.16764	0.81013
24	49.21050	0.80693
24	49.25336	0.80373
24	49.29622	0.80053
24	49.33907	0.79733
24	49.38193	0.79413
24	49.42479	0.79093
24	49.46764	0.78773
24	49.51050	0.78453
24	49.55336	0.78133
24	49.59622	0.77813
24	49.63907	0.77493
24	49.68193	0.77173
24	49.72479	0.76853
24	49.76764	0.76533
24	49.81050	0.76213
24	49.85336	0.75893
24	49.89622	0.75573
24	49.93907	0.75253
24	49.98193	0.74933
24	50.02479	0.74613
24	50.06764	0.74293
24	50.11050	0.73973
24	50.15336	0.73653
24	50.19622	0.73333
24	50.23907	0.73013
24	50.28193	0.72693
24	50.32479	0.72373
24	50.36764	0.72053
24	50.41050	0.71733
24	50.45336	0.71413
24	50.49622	0.71093
24	50.53907	0.70773
24	50.58193	0.70453
24	50.62479	0.70133
24	50.66764	0.69813
24	50.71050	0.69493
24	50.75336	0.69173
24	50.79622	0.68853
24	50.83907	0.68533
24	50.88193	0.68213
24	50.92479	0.67893
24	50.96764	0.67573
24	51.01050	0.67253
24	51.05336	0.66933
24	51.09622	0.66613
24	51.13907	0.66293
24	51.18193	0.65973
24	51.22479	0.65653
24	51.26764	0.65333
24	51.31050	0.65013
24	51.35336	0.64693
24	51.39622	0.64373
24	51.43907	0.64053
24	51.48193	0.63733
24	51.52479	0.63413
24	51.56764	0.63093
24	51.61050	0.62773
24	51.65336	0.62453
24	51.69622	0.62133
24	51.73907	0.61813
24	51.78193	0.61493
24	51.82479	0.61173
24	51.86764	0.60853
24	51.91050	0.60533
24	51.95336	0.60213
24	51.99622	0.59893
24	52.03907	0.59573
24	52.08193	0.59253
24	52.12479	0.58933
24	52.16764	0.58613
24	52.21050	0.58293
24	52.25336	0.57973
24	52.29622	0.57653
24	52.33907	0.57333
24	52.38193	0.57013
24	52.42479	0.56693
24	52.46764	0.56373
24	52.51050	0.56053
24	52.55336	0.55733
24	52.59622	0.55413
24	52.63907	0.55093
24	52.68193	0.54773
24	52.72479	0.54453
24	52.76764	0.54133
24	52.81050	0.53813
24	52.85336	0.53493
24	52.89622	0.53173
24	52.93907	0.52853
24	52.98193	0.52533
24	53.02479	0.52213
24	53.06764	0.51893
24	53.11050	0.51573
24	53.15336	0.51253
24	53.19622	0.50933
24	53.23907	0.50613
24	53.28193	0.50293
24	53.32479	0.49973
24	53.36764	0.49653
24	53.41050	0.49333
24	53.45336	0.49013
24	53.49622	0.48693
24	53.53907	0.48373
24	53.58193	0.48053
24	53.62479	0.47733
24	53.66764	0.47413
24	53.71050	0.47093
24	53.75336	0.46773
24	53.79622	0.46453
24	53.83907	0.46133
24	53.88193	0.45813
24	53.92479	0.45493
24	53.96764	0.45173
24	54.01050	0.44853
24	54.05336	0.44533
24	54.09622	0.44213
24	54.13907	0.43893
24	54.18193	0.43573
24	54.22479	0.43253
24	54.26764	0.42933
24	54.31050	0.42613
24	54.35336	0.42293
24	54.39622	0.41973
24	54.43907	0.41653
24	54.48193	0.41333
24	54.52479	0.41013
24	54.56764	0.40693
24	54.61050	0.40373
24	54.65336	0.40053
24	54.69622	0.39733
24	54.73907	0.39413
24	54.78193	0.39093
24	54.82479	0.38773
24	54.86764	0.38453
24	54.91050	0.38133
24	54.95336	0.37813
24	54.99622	0.37493
24	55.03907	0.37173
24	55.08193	0.36853
24	55.12479	0.36533
24	55.16764	0.36213
24	55.21050	0.35893
24	55.25336	0.35573
24	55.29622	0.35253
24	55.33907	0.34933
24	55.38193	0.34613
24	55.42479	0.34293
24	55.46764	0.33973
24	55.51050	0.33653
24	55.55336	0.33333
24	55.59622	0.33013
24	55.63907	0.32693
24	55.68193	0.32373
24	55.72479	0.32053
24	55.76764	0.31733
24	55.81050	0.31413
24	55.85336	0.31093
24	55.89622	0.30773
24	55.93907	0.30453
24	55.98193	0.30133
24	56.02479	0.29813
24	56.06764	0.29493
24	56.11050	0.29173
24	56.15336	0.28853
24	56.19622	0.28533
24	56.23907	0.28213
24	56.28193	0.27893
24	56.32479	0.27573
24	56.36764	0.27253
24	56.41050	0.26933
24	56.45336	0.26613
24	56.49622	0.26293
24	56.53907	0.25973
24	56.58193	0.25653
24	56.62479	0.25333
24	56.66764	0.25013
24	56.71050	0.24693
24	56.75336	0.24373
24	56.79622	0.24053
24	56.83907	0.23733
24	56.88193	0.23413
24	56.92479	0.23093
24	56.96764	0.22773
24	57.01050	0.22453
24	57.05336	0.22133
24	57.09622	0.21813
24	57.13907	0.21493
24	57.18193	0.21173
24	57.22479	0.20853
24	57.26764	0.20533
24	57.31050	0.20213
24	57.35336	0.19893
24	57.39622	0.19573
24	57.43907	0.19253
24	57.48193	0.18933
24	57.52479	0.18613
24	57.56764	0.18293
24	57.61050	0.17973
24	57.65336	0.17653
24	57.69622	0.17333
24	57.73907	0.17013
24	57.78193	0.16693
24	57.82479	0.16373
24	57.86764	0.16053
24	57.91050	0.15733
24	57.95336	0.15413
24	57.99622	0.15093
24	58.03907	0.14773
24	58.08193	0.14453
24	58.12479	0.14133
24	58.16764	0.13813
24	58.21050	0.13493
24	58.25336	0.13173
24	58.29622	0.12853
24	58.33907	0.12533
24	58.38193	0.12213
24	58.42479	0.11893
24	58.46764	0.11573
24	58.51050	0.11253
24	58.55336	0.10933
24	58.59622	0.10613
24	58.63907	0.10293
24	58.68193	0.09973
24	58.72479	0.09653
24	58.76764	0.09333
24	58.81050	0.09013
24	58.85336	0.08693
24	58.89622	0.08373
24	58.93907	0.08053
24	58.98193	0.07733
24	59.02479	0.07413
24	59.06764	0.07093
24	59.11050	0.06773
24	59.15336	0.06453
24	59.19622	0.06133
24	59.23907	0.05813
24	59.28193	0.05493
24	59.32479	0.05173
24	59.36764	0.04853
24	59.41050	0.04533
24	59.45336	0.04213
24	59.49622	0.03893
24	59.53907	0.03573
24	59.58193	0.03253
24	59.62479	0.02933
24	59.66764	0.02613
24	59.71050	0.02293
24	59.75336	0.01973
24	59.79622	0.01653
24	59.83907	0.01333
24	59.88193	0.01013
24	59.92479	0.00693
24	59.96764	0.00373
24	60.01050	0.00053

BLADE NO. 25	SHOCK POSITION 51.91799	UNINTERCEPTED WAVE POSITION 52.56087	PERIPHERAL DISTANCE	PRESSURE RATIO
25	47.99420	1.05033		
25	48.03706	1.04673		
25	48.07992	1.04316		
25	48.12277	1.03963		
25	48.16563	1.03613		
25	48.20849	1.03266		
25	48.25135	1.02923		
25	48.29421	1.02583		
25	48.33707	1.02246		
25	48.37993	1.01913		
25	48.42279	1.01583		
25	48.46564	1.01256		
25	48.50850	1.00932		
25	48.55136	1.00612		
25	48.59422	1.00294		
25	48.63708	0.99980		
25	48.67982	0.99446		
25	48.72376	0.98927		
25	48.76756	0.98411		
25	48.81136	0.97897		
25	48.85516	0.97387		
25	48.89896	0.96879		
25	48.94276	0.96373		
25	48.98656	0.95871		
25	49.03036	0.95371		
25	49.07416	0.94874		
25	49.11796	0.94379		
25	49.16176	0.93888		
25	49.20556	0.93399		
25	49.24936	0.92912		
25	49.29316	0.92428		
25	49.33696	0.91947		
25	49.38076	0.91468		
25	49.42456	0.90980		
25	49.46836	0.90492		
25	49.51216	0.89999		
25	49.55596	0.89506		
25	49.59976	0.89013		
25	49.64356	0.88520		
25	49.68736	0.88027		
25	49.73116	0.87534		
25	49.77496	0.87041		
25	49.81876	0.86548		
25	49.86256	0.86055		
25	49.90636	0.85562		
25	49.95016	0.85069		
25	49.99396	0.84576		
25	50.03776	0.84083		
25	50.08156	0.83590		
25	50.12536	0.83097		
25	50.16916	0.82604		
25	50.21296	0.82111		
25	50.25676	0.81618		
25	50.30056	0.81125		
25	50.34436	0.80632		
25	50.38816	0.80139		
25	50.43196	0.79646		
25	50.47576	0.79153		
25	50.51956	0.78660		
25	50.56336	0.78167		
25	50.60716	0.77674		
25	50.65096	0.77181		
25	50.69476	0.76688		
25	50.73856	0.76195		
25	50.78236	0.75702		
25	50.82616	0.75209		
25	50.86996	0.74716		
25	50.91376	0.74223		
25	50.95756	0.73730		
25	51.00136	0.73237		
25	51.04516	0.72744		
25	51.08896	0.72251		
25	51.13276	0.71758		
25	51.17656	0.71265		
25	51.22036	0.70772		
25	51.26416	0.70279		
25	51.30796	0.69786		
25	51.35176	0.69293		
25	51.39556	0.68800		
25	51.43936	0.68307		
25	51.48316	0.67814		
25	51.52696	0.67321		
25	51.57076	0.66828		
25	51.61456	0.66335		
25	51.65836	0.65842		
25	51.70216	0.65349		
25	51.74596	0.64856		
25	51.78976	0.64363		
25	51.83356	0.63870		
25	51.87736	0.63377		
25	51.92116	0.62884		
25	51.96496	0.62391		
25	52.00876	0.61898		
25	52.05256	0.61405		
25	52.09636	0.60912		
25	52.14016	0.60419		
25	52.18396	0.59926		
25	52.22776	0.59433		
25	52.27156	0.58940		
25	52.31536	0.58447		
25	52.35916	0.57954		
25	52.40296	0.57461		
25	52.44676	0.56968		
25	52.49056	0.56475		
25	52.53436	0.55982		
25	52.57816	0.55489		
25	52.62196	0.54996		
25	52.66576	0.54503		
25	52.70956	0.54010		
25	52.75336	0.53517		
25	52.79716	0.53024		
25	52.84096	0.52531		
25	52.88476	0.52038		
25	52.92856	0.51545		
25	52.97236	0.51052		
25	53.01616	0.50559		
25	53.05996	0.50066		
25	53.10376	0.49573		
25	53.14756	0.49080		
25	53.19136	0.48587		
25	53.23516	0.48094		
25	53.27896	0.47601		
25	53.32276	0.47108		
25	53.36656	0.46615		
25	53.41036	0.46122		
25	53.45416	0.45629		
25	53.49796	0.45136		
25	53.54176	0.44643		
25	53.58556	0.44150		
25	53.62936	0.43657		
25	53.67316	0.43164		
25	53.71696	0.42671		
25	53.76076	0.42178		
25	53.80456	0.41685		
25	53.84836	0.41192		
25	53.89216	0.40699		
25	53.93596	0.40206		
25	53.97976	0.39713		
25	54.02356	0.39220		
25	54.06736	0.38727		
25	54.11116	0.38234		
25	54.15496	0.37741		
25	54.19876	0.37248		
25	54.24256	0.36755		
25	54.28636	0.36262		
25	54.33016	0.35769		
25	54.37396	0.35276		
25	54.41776	0.34783		
25	54.46156	0.34290		
25	54.50536	0.33797		
25	54.54916	0.33304		
25	54.59296	0.32811		
25	54.63676	0.32318		
25	54.68056	0.31825		
25	54.72436	0.31332		
25	54.76816	0.30839		
25	54.81196	0.30346		
25	54.85576	0.29853		
25	54.89956	0.29360		
25	54.94336	0.28867		
25	54.98716	0.28374		
25	55.03096	0.27881		
25	55.07476	0.27388		
25	55.11856	0.26895		
25	55.16236	0.26402		
25	55.20616	0.25909		
25	55.24996	0.25416		
25	55.29376	0.24923		
25	55.33756	0.24430		
25	55.38136	0.23937		
25	55.42516	0.23444		
25	55.46896	0.22951		
25	55.51276	0.22458		
25	55.55656	0.21965		
25	55.60036	0.21472		
25	55.64416	0.20979		
25	55.68796	0.20486		
25	55.73176	0.19993		
25	55.77556	0.19500		
25	55.81936	0.19007		
25	55.86316	0.18514		
25	55.90696	0.18021		
25	55.95076	0.17528		
25	55.99456	0.17035		
25	56.03836	0.16542		
25	56.08216	0.16049		
25	56.12596	0.15556		
25	56.16976	0.15063		
25	56.21356	0.14570		
25	56.25736	0.14077		
25	56.30116	0.13584		
25	56.34496	0.13091		
25	56.38876	0.12598		
25	56.43256	0.12105		
25	56.47636	0.11612		
25	56.52016	0.11119		
25	56.56396	0.10626		
25	56.60776	0.10133		
25	56.65156	0.09640		
25	56.69536	0.09147		
25	56.73916	0.08654		
25	56.78296	0.08161		
25	56.82676	0.07668		
25	56.87056	0.07175		
25	56.91436	0.06682		
25	56.95816	0.06189		
25	57.00196	0.05696		
25	57.04576	0.05203		
25	57.08956	0.04710		
25	57.13336	0.04217		
25	57.17716	0.03724		
25	57.22096	0.03231		
25	57.26476	0.02738		
25	57.30856	0.02245		
25	57.35236	0.01752		
25	57.39616	0.01259		
25	57.43996	0.00766		
25	57.48376	0.00273		
25	57.52756	0.00000		

PROFILE NUMBER IS 25 NUMBER OF DIVISIONS ARE 34

BLADE NO.	SHOCK POSITION	UNINTERCEPTED WAVE POSITION	PERIPHERAL DISTANCE	PRESSURE RATIO
26	53.91599	54.55086		
26			49.99800	1.05018
26			50.04074	1.04659
26			50.04348	1.04303
26			50.12622	1.03951
26			50.16896	1.03602
26			50.21169	1.03257
26			50.25443	1.02914
26			50.29717	1.02576
26			50.33991	1.02240
26			50.38265	1.01907
26			50.42539	1.01578
26			50.46813	1.01252
26			50.51086	1.00930
26			50.55360	1.00610
26			50.59634	1.00293
26			50.63908	0.99980
26			50.71282	0.99446
26			50.74576	0.98927
26			50.85956	0.98411
26			50.93424	0.97897
26			51.00981	0.97387
26			51.08630	0.96879
26			51.16374	0.96373
26			51.24214	0.95871
26			51.32152	0.95371
26			51.40192	0.94874
26			51.48336	0.94379
26			51.56587	0.93888
26			51.64947	0.93399
26			51.73420	0.92912
26			51.82009	0.92428
26			51.90718	0.91947
26			51.99550	0.91468
26			52.00000	0.91444

PROFILE NUMBER IS 26

NUMBER OF DIVISIONS ARE 34

BLADE NO.
27

SHOCK POSITION
55.91980

UNINTERCEPTED WAVE POSITION
56.56087

PROFILE NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
27	52.00000	1.05018
27	52.04274	1.04659
27	52.04548	1.04303
27	52.12822	1.03951
27	52.17095	1.03602
27	52.21369	1.03257
27	52.25643	1.02914
27	52.29917	1.02576
27	52.34191	1.02240
27	52.36465	1.01907
27	52.42739	1.01578
27	52.47013	1.01252
27	52.51286	1.00930
27	52.55560	1.00610
27	52.59834	1.00293
27	52.64108	0.99980
27	52.71463	0.99448
27	52.78737	0.98930
27	52.86097	0.98415
27	52.93544	0.97903
27	53.01081	0.97393

27	53.08709	0.96887
27	53.16430	0.96382
27	53.24248	0.95881
27	53.32163	0.95383
27	53.40179	0.94887
27	53.48299	0.94394
27	53.56524	0.93903
27	53.64859	0.93415
27	53.73306	0.92930
27	53.81868	0.92448
27	53.90549	0.91967
27	53.99352	0.91490
27	53.99620	0.91475

PROFILE NUMBER IS 27

NUMBER OF DIVISIONS ARE 34

BLADE NO.	SHOCK POSITION 57.92179	PROFILE NUMBER	UNINTERCEPTED WAVE POSITION 58.56257	PERIPHERAL DISTANCE	PRESSURE RATIO
28	28	53.99620			1.05033
28	28	54.03906			1.04673
28	28	54.06191			1.04316
28	28	54.12477			1.03963
28	28	54.16763			1.03613
28	28	54.21049			1.03266
28	28	54.25335			1.02923
28	28	54.29621			1.02583
28	28	54.33907			1.02246
28	28	54.38193			1.01913
28	28	54.42479			1.01583
28	28	54.46764			1.01256
28	28	54.51050			1.00932
28	28	54.55336			1.00612
28	28	54.59622			1.00294
28	28	54.63908			0.99980
28	28	54.71282			0.99446
28	28	54.78576			0.98927
28	28	54.85956			0.98411
28	28	54.93424			0.97897
28	28	55.00981			0.97387
28	28	55.08630			0.96879
28	28	55.16374			0.96373
28	28	55.24214			0.95871
28	28	55.32152			0.95371
28	28	55.40192			0.94874
28	28	55.48336			0.94379
28	28	55.56587			0.93888
28	28	55.64947			0.93399
28	28	55.73420			0.92912
28	28	55.82009			0.92428
28	28	55.90718			0.91947
28	28	55.99550			0.91468
28	28	56.00000			0.91444

PROFILE NUMBER IS 28

NUMBER OF DIVISIONS ARE 34

BLADE NO.
29

SHOCK POSITION
59.91799

UNINTERCEPTED WAVE POSITION
60.56087

PROFILE NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
29	56.00000	1.05018
29	56.04274	1.04659
29	56.08548	1.04303
29	56.12822	1.03951
29	56.17096	1.03602
29	56.21369	1.03257
29	56.25643	1.02914
29	56.29917	1.02576
29	56.34191	1.02240
29	56.38465	1.01907
29	56.42739	1.01578
29	56.47013	1.01252
29	56.51286	1.00930
29	56.55560	1.00610
29	56.59834	1.00293
29	56.64108	0.99980
29	56.68382	0.99666
29	56.72656	0.99352
29	56.76930	0.99038
29	56.81204	0.98724
29	56.85478	0.98410
29	56.89752	0.98096
29	56.94026	0.97782
29	56.98300	0.97468
29	57.02574	0.97154
29	57.06848	0.96840
29	57.11122	0.96526
29	57.15396	0.96212
29	57.19670	0.95898
29	57.23944	0.95584
29	57.28218	0.95270
29	57.32492	0.94956
29	57.36766	0.94642
29	57.41040	0.94328
29	57.45314	0.94014
29	57.49588	0.93700
29	57.53862	0.93386
29	57.58136	0.93072
29	57.62410	0.92758
29	57.66684	0.92444
29	57.70958	0.92130
29	57.75232	0.91816
29	57.79506	0.91502
29	57.83780	0.91188
29	57.88054	0.90874
29	57.92328	0.90560
29	57.96602	0.90246
29	58.00876	0.89932

PROFILE NUMBER IS 29

NUMBER OF DIVISIONS ARE 34

BLADE NO.	SHOCK POSITION	UNINTERCEPTED WAVE POSITION	PERIPHERAL DISTANCE	PRESSURE RATIO
30	61.92140	62.56267		
	PROFILE NUMBER			
	30		58.00200	1.05018
	30		58.04474	1.04659
	30		58.08748	1.04393
	30		58.13022	1.03931
	30		58.17296	1.03602
	30		58.21569	1.03257
	30		58.25843	1.02914
	30		58.30117	1.02576
	30		58.34391	1.02240
	30		58.38665	1.01907
	30		58.42939	1.01578
	30		58.47213	1.01252
	30		58.51486	1.00930
	30		58.55760	1.00610
	30		58.60034	1.00293
	30		58.64308	0.99930
	30		58.68582	0.99418
	30		58.72856	0.98910
	30		58.86297	0.98415
	30		58.90571	0.97903
	30		59.01281	0.97393
	30		59.08909	0.96837
	30		59.16530	0.96382
	30		59.24148	0.95881
	30		59.32363	0.95383
	30		59.40579	0.94887
	30		59.48499	0.94394
	30		59.56724	0.93933
	30		59.65059	0.93415
	30		59.73506	0.92930
	30		59.82068	0.92448
	30		59.90749	0.91967
	30		59.99552	0.91490
	30		59.99020	0.91475

PROFILE NUMBER IS 30 NUMBER OF DIVISIONS ARE 34

BLADE NO. 31	SHOCK POSITION 63.92380	UNINTERCEPTED WAVE POSITION 64.56487	PERIPHERAL DISTANCE	PRESSURE RATIO
31	59.99820		1.05033	
31	60.04105		1.04673	
31	60.08391		1.04316	
31	60.12677		1.03963	
31	60.16963		1.03613	
31	60.21249		1.03266	
31	60.25535		1.02923	
31	60.29821		1.02563	
31	60.34107		1.02246	
31	60.38393		1.01913	
31	60.42678		1.01583	
31	60.46964		1.01256	
31	60.51250		1.00932	
31	60.55536		1.00612	
31	60.59822		1.00294	
31	60.64108		0.99980	
31	60.68394		0.99666	
31	60.72679		0.99352	
31	60.76965		0.99038	
31	60.81251		0.98724	
31	60.85537		0.98411	
31	60.89823		0.98097	
31	60.94109		0.97783	
31	60.98395		0.97469	
31	61.02681		0.97155	
31	61.06967		0.96841	
31	61.11253		0.96527	
31	61.15539		0.96213	
31	61.19825		0.95899	
31	61.24111		0.95585	
31	61.28397		0.95271	
31	61.32683		0.94957	
31	61.36969		0.94643	
31	61.41255		0.94329	
31	61.45541		0.94015	
31	61.49827		0.93701	
31	61.54113		0.93387	
31	61.58399		0.93073	
31	61.62685		0.92759	
31	61.66971		0.92445	
31	61.71257		0.92131	
31	61.75543		0.91817	
31	61.79829		0.91503	
31	61.84115		0.91189	
31	61.88401		0.90875	
31	61.92687		0.90561	
31	61.96973		0.90247	
31	62.01259		0.89933	
31	62.05545		0.89619	
31	62.09831		0.89305	
31	62.14117		0.88991	
31	62.18403		0.88677	
31	62.22689		0.88363	
31	62.26975		0.88049	
31	62.31261		0.87735	
31	62.35547		0.87421	
31	62.39833		0.87107	
31	62.44119		0.86793	
31	62.48405		0.86479	
31	62.52691		0.86165	
31	62.56977		0.85851	
31	62.61263		0.85537	
31	62.65549		0.85223	
31	62.69835		0.84909	
31	62.74121		0.84595	
31	62.78407		0.84281	
31	62.82693		0.83967	
31	62.86979		0.83653	
31	62.91265		0.83339	
31	62.95551		0.83025	
31	62.99837		0.82711	
31	63.04123		0.82397	
31	63.08409		0.82083	
31	63.12695		0.81769	
31	63.16981		0.81455	
31	63.21267		0.81141	
31	63.25553		0.80827	
31	63.29839		0.80513	
31	63.34125		0.80199	
31	63.38411		0.79885	
31	63.42697		0.79571	
31	63.46983		0.79257	
31	63.51269		0.78943	
31	63.55555		0.78629	
31	63.59841		0.78315	
31	63.64127		0.78001	
31	63.68413		0.77687	
31	63.72699		0.77373	
31	63.76985		0.77059	
31	63.81271		0.76745	
31	63.85557		0.76431	
31	63.89843		0.76117	
31	63.94129		0.75803	
31	63.98415		0.75489	
31	64.02701		0.75175	
31	64.06987		0.74861	
31	64.11273		0.74547	
31	64.15559		0.74233	
31	64.19845		0.73919	
31	64.24131		0.73605	
31	64.28417		0.73291	
31	64.32703		0.72977	
31	64.36989		0.72663	
31	64.41275		0.72349	
31	64.45561		0.72035	
31	64.49847		0.71721	
31	64.54133		0.71407	
31	64.58419		0.71093	
31	64.62705		0.70779	
31	64.66991		0.70465	
31	64.71277		0.70151	
31	64.75563		0.69837	
31	64.79849		0.69523	
31	64.84135		0.69209	
31	64.88421		0.68895	
31	64.92707		0.68581	
31	64.96993		0.68267	
31	65.01279		0.67953	
31	65.05565		0.67639	
31	65.09851		0.67325	
31	65.14137		0.67011	
31	65.18423		0.66697	
31	65.22709		0.66383	
31	65.26995		0.66069	
31	65.31281		0.65755	
31	65.35567		0.65441	
31	65.39853		0.65127	
31	65.44139		0.64813	
31	65.48425		0.64499	
31	65.52711		0.64185	
31	65.56997		0.63871	
31	65.61283		0.63557	
31	65.65569		0.63243	
31	65.69855		0.62929	
31	65.74141		0.62615	
31	65.78427		0.62301	
31	65.82713		0.61987	
31	65.86999		0.61673	
31	65.91285		0.61359	
31	65.95571		0.61045	
31	65.99857		0.60731	
31	66.04143		0.60417	
31	66.08429		0.60103	
31	66.12715		0.59789	
31	66.16991		0.59475	
31	66.21277		0.59161	
31	66.25563		0.58847	
31	66.29849		0.58533	
31	66.34135		0.58219	
31	66.38421		0.57905	
31	66.42707		0.57591	
31	66.46993		0.57277	
31	66.51279		0.56963	
31	66.55565		0.56649	
31	66.59851		0.56335	
31	66.64137		0.56021	
31	66.68423		0.55707	
31	66.72709		0.55393	
31	66.76995		0.55079	
31	66.81281		0.54765	
31	66.85567		0.54451	
31	66.89853		0.54137	
31	66.94139		0.53823	
31	66.98425		0.53509	
31	67.02711		0.53195	
31	67.06997		0.52881	
31	67.11283		0.52567	
31	67.15569		0.52253	
31	67.19855		0.51939	
31	67.24141		0.51625	
31	67.28427		0.51311	
31	67.32713		0.50997	
31	67.36999		0.50683	
31	67.41285		0.50369	
31	67.45571		0.50055	
31	67.49857		0.49741	
31	67.54143		0.49427	
31	67.58429		0.49113	
31	67.62715		0.48799	
31	67.66991		0.48485	
31	67.71277		0.48171	
31	67.75563		0.47857	
31	67.79849		0.47543	
31	67.84135		0.47229	
31	67.88421		0.46915	
31	67.92707		0.46601	
31	67.96993		0.46287	
31	68.01279		0.45973	
31	68.05565		0.45659	
31	68.09851		0.45345	
31	68.14137		0.45031	
31	68.18423		0.44717	
31	68.22709		0.44403	
31	68.26995		0.44089	
31	68.31281		0.43775	
31	68.35567		0.43461	
31	68.39853		0.43147	
31	68.44139		0.42833	
31	68.48425		0.42519	
31	68.52711		0.42205	
31	68.56997		0.41891	
31	68.61283		0.41577	
31	68.65569		0.41263	
31	68.69855		0.40949	
31	68.74141		0.40635	
31	68.78427		0.40321	
31	68.82713		0.40007	
31	68.86999		0.39693	
31	68.91285		0.39379	
31	68.95571		0.39065	
31	68.99857		0.38751	
31	69.04143		0.38437	
31	69.08429		0.38123	
31	69.12715		0.37809	
31	69.16991		0.37495	
31	69.21277		0.37181	
31	69.25563		0.36867	
31	69.29849		0.36553	
31	69.34135		0.36239	
31	69.38421		0.35925	
31	69.42707		0.35611	
31	69.46993		0.35297	
31	69.51279		0.34983	
31	69.55565		0.34669	
31	69.59851		0.34355	
31	69.64137		0.34041	
31	69.68423		0.33727	
31	69.72709		0.33413	
31	69.76995		0.33099	
31	69.81281		0.32785	
31	69.85567		0.32471	
31	69.89853		0.32157	
31	69.94139		0.31843	
31	69.98425		0.31529	
31	70.02711		0.31215	
31	70.06997		0.30901	
31	70.11283		0.30587	
31	70.15569		0.30273	
31	70.19855		0.29959	
31	70.24141		0.29645	
31	70.28427		0.29331	
31	70.32713		0.29017	
31	70.36999		0.28703	
31	70.41285		0.28389	
31	70.45571		0.28075	
31	70.49857		0.27761	
31	70.54143		0.27447	
31	70.58429		0.27133	
31	70.62715		0.26819	
31	70.66991		0.26505	
31	70.71277		0.26191	
31	70.75563		0.25877	
31	70.79849		0.25563	
31	70.84135		0.25249	
31	70.88421		0.24935	
31	70.92707		0.24621	
31	70.96993		0.24307	
31	71.01279		0.23993	
31	71.05565		0.23679	
31	71.09851		0.23365	
31	71.14137		0.23051	
31	71.18423		0.22737	
31	71.22709		0.22423	
31	71.26995		0.22109	
31	71.31281		0.21795	
31	71.35567		0.21481	
31	71.39853		0.21167	
31	71.44139		0.20853	
31	71.48425		0.20539	
31	71.52711		0.20225	
31	71.56997		0.19911	
31	71.61283		0.19597	
31	71.65569		0.19283	
31	71.69855		0.18969	
31	71.74141		0.18655	
31	71.78427		0.18341	
31	71.82713		0.18027	
31	71.86999		0.17713	
31	71.91285		0.17399	
31	71.95571		0.17085	
31	72.0		0.16771	

PROFILE NUMBER IS 31 NUMBER OF DIVISIONS ARE 34

BLADE NO. 32	SHOCK POSITION 65.91999	UNINTERCEPTED WAVE POSITION 66.56287	PERIPHERAL DISTANCE	PRESSURE RATIO
32	32	62.00200	1.05018	
32	32	62.04474	1.04659	
32	32	62.06748	1.04303	
32	32	62.13022	1.03951	
32	32	62.17295	1.03602	
32	32	62.21569	1.03257	
32	32	62.25843	1.02914	
32	32	62.30117	1.02576	
32	32	62.34391	1.02240	
32	32	62.38665	1.01907	
32	32	62.42939	1.01578	
32	32	62.47213	1.01252	
32	32	62.51486	1.00930	
32	32	62.55760	1.00610	
32	32	62.60034	1.00293	
32	32	62.64308	0.99980	
32	32	62.68582	0.99668	
32	32	62.72856	0.99356	
32	32	62.77130	0.99044	
32	32	62.81404	0.98732	
32	32	62.85678	0.98420	
32	32	62.89952	0.98108	
32	32	62.94226	0.97796	
32	32	62.98500	0.97484	
32	32	63.02774	0.97172	
32	32	63.07048	0.96860	
32	32	63.11322	0.96548	
32	32	63.15596	0.96236	
32	32	63.19870	0.95924	
32	32	63.24144	0.95612	
32	32	63.28418	0.95300	
32	32	63.32692	0.94988	
32	32	63.36966	0.94676	
32	32	63.41240	0.94364	
32	32	63.45514	0.94052	
32	32	63.49788	0.93740	
32	32	63.54062	0.93428	
32	32	63.58336	0.93116	
32	32	63.62610	0.92804	
32	32	63.66884	0.92492	
32	32	63.71158	0.92180	
32	32	63.75432	0.91868	
32	32	63.79706	0.91556	
32	32	63.83980	0.91244	
32	32	63.88254	0.90932	
32	32	63.92528	0.90620	
32	32	63.96802	0.90308	

PROFILE NUMBER IS 32

NUMBER OF DIVISIONS ARE 34

BLADE NO.
33

SHOCK POSITION
67.92379

UNINTERCEPTED WAVE POSITION
68.56488

PROFILE NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
33	63.99820	1.05033
33	64.04106	1.04673
33	64.08392	1.04316
33	64.12677	1.03963
33	64.16963	1.03613
33	64.21249	1.03266
33	64.25535	1.02923
33	64.29821	1.02563
33	64.34107	1.02246
33	64.38393	1.01913
33	64.42679	1.01583
33	64.46965	1.01256
33	64.51250	1.00932
33	64.55536	1.00612
33	64.59822	1.00294

33	64.64108	0.99960
33	64.71482	0.99446
33	64.78776	0.98927
33	64.86156	0.98411
33	64.93623	0.97897
33	65.01181	0.97367
33	65.08831	0.96879
33	65.16574	0.96373
33	65.24414	0.95871
33	65.32352	0.95371
33	65.40392	0.94874
33	65.48536	0.94379
33	65.56787	0.93888
33	65.65147	0.93359
33	65.73620	0.92912
33	65.82209	0.92428
33	65.90918	0.91947
33	65.99750	0.91468
33	66.00200	0.91444

PROFILE NUMBER IS 33

NUMBER OF DIVISIONS ARE 34

BLADE NO. 34	SHOCK POSITION 69.91999	PROFILE NUMBER	UNINTERCEPTED WAVE POSITION 70.56288	PERIPHERAL DISTANCE	PRESSURE RATIO
		34		66.00200	1.05018
		34		66.04474	1.04659
		34		66.08748	1.04303
		34		66.13022	1.03951
		34		66.17295	1.03602
		34		66.21569	1.03257
		34		66.25843	1.02914
		34		66.30117	1.02576
		34		66.34391	1.02240
		34		66.38665	1.01907
		34		66.42939	1.01578
		34		66.47213	1.01252
		34		66.51486	1.00930
		34		66.55760	1.00610
		34		66.60034	1.00293
		34		66.64308	0.99980
		34		66.68582	0.99667
		34		66.72856	0.99354
		34		66.77130	0.99041
		34		66.81404	0.98728
		34		66.85678	0.98415
		34		66.89952	0.98102
		34		66.94226	0.97789
		34		66.98500	0.97476
		34		67.02774	0.97163
		34		67.07048	0.96850
		34		67.11322	0.96537
		34		67.15596	0.96224
		34		67.19870	0.95911
		34		67.24144	0.95598
		34		67.28418	0.95285
		34		67.32692	0.94972
		34		67.36966	0.94659
		34		67.41240	0.94346
		34		67.45514	0.94033
		34		67.49788	0.93720
		34		67.54062	0.93407
		34		67.58336	0.93094
		34		67.62610	0.92781
		34		67.66884	0.92468
		34		67.71158	0.92155
		34		67.75432	0.91842
		34		67.79706	0.91529
		34		67.83980	0.91216
		34		67.88254	0.90903
		34		67.92528	0.90590
		34		67.96802	0.90277
		34		68.01076	0.89964
		34		68.05350	0.89651
		34		68.09624	0.89338
		34		68.13898	0.89025
		34		68.18172	0.88712
		34		68.22446	0.88399
		34		68.26720	0.88086
		34		68.30994	0.87773
		34		68.35268	0.87460
		34		68.39542	0.87147
		34		68.43816	0.86834
		34		68.48090	0.86521
		34		68.52364	0.86208
		34		68.56638	0.85895
		34		68.60912	0.85582
		34		68.65186	0.85269
		34		68.69460	0.84956
		34		68.73734	0.84643
		34		68.78008	0.84330
		34		68.82282	0.84017
		34		68.86556	0.83704
		34		68.90830	0.83391
		34		68.95104	0.83078
		34		68.99378	0.82765
		34		69.03652	0.82452
		34		69.07926	0.82139
		34		69.12200	0.81826
		34		69.16474	0.81513
		34		69.20748	0.81200
		34		69.25022	0.80887
		34		69.29296	0.80574
		34		69.33570	0.80261
		34		69.37844	0.79948
		34		69.42118	0.79635
		34		69.46392	0.79322
		34		69.50666	0.79009
		34		69.54940	0.78696
		34		69.59214	0.78383
		34		69.63488	0.78070
		34		69.67762	0.77757
		34		69.72036	0.77444
		34		69.76310	0.77131
		34		69.80584	0.76818
		34		69.84858	0.76505
		34		69.89132	0.76192
		34		69.93406	0.75879
		34		69.97680	0.75566
		34		70.01954	0.75253
		34		70.06228	0.74940
		34		70.10502	0.74627
		34		70.14776	0.74314
		34		70.19050	0.74001
		34		70.23324	0.73688
		34		70.27598	0.73375
		34		70.31872	0.73062
		34		70.36146	0.72749
		34		70.40420	0.72436
		34		70.44694	0.72123
		34		70.48968	0.71810
		34		70.53242	0.71497
		34		70.57516	0.71184
		34		70.61790	0.70871
		34		70.66064	0.70558
		34		70.70338	0.70245
		34		70.74612	0.69932
		34		70.78886	0.69619
		34		70.83160	0.69306
		34		70.87434	0.68993
		34		70.91708	0.68680
		34		70.95982	0.68367
		34		71.00256	0.68054
		34		71.04530	0.67741
		34		71.08804	0.67428
		34		71.13078	0.67115
		34		71.17352	0.66802
		34		71.21626	0.66489
		34		71.25900	0.66176
		34		71.30174	0.65863
		34		71.34448	0.65550
		34		71.38722	0.65237
		34		71.42996	0.64924
		34		71.47270	0.64611
		34		71.51544	0.64298
		34		71.55818	0.63985
		34		71.60092	0.63672
		34		71.64366	0.63359
		34		71.68640	0.63046
		34		71.72914	0.62733
		34		71.77188	0.62420
		34		71.81462	0.62107
		34		71.85736	0.61794
		34		71.89960	0.61481
		34		71.94234	0.61168
		34		71.98508	0.60855
		34		72.02782	0.60542
		34		72.07056	0.60229
		34		72.11330	0.59916
		34		72.15604	0.59603
		34		72.19878	0.59290
		34		72.24152	0.58977
		34		72.28426	0.58664
		34		72.32700	0.58351
		34		72.36974	0.58038
		34		72.41248	0.57725
		34		72.45522	0.57412
		34		72.49796	0.57099
		34		72.54070	0.56786
		34		72.58344	0.56473
		34		72.62618	0.56160
		34		72.66892	0.55847
		34		72.71166	0.55534
		34		72.75440	0.55221
		34		72.79714	0.54908
		34		72.83988	0.54595
		34		72.88262	0.54282
		34		72.92536	0.53969
		34		72.96810	0.53656
		34		73.01084	0.53343
		34		73.05358	0.53030
		34		73.09632	0.52717
		34		73.13906	0.52404
		34		73.18180	0.52091
		34		73.22454	0.51778
		34		73.26728	0.51465
		34		73.31002	0.51152
		34		73.35276	0.50839
		34		73.39550	0.50526
		34		73.43824	0.50213
		34		73.48098	0.49900
		34		73.52372	0.49587
		34		73.56646	0.49274
		34		73.60920	0.48961
		34		73.65194	0.48648
		34		73.69468	0.48335
		34		73.73742	0.48022
		34		73.78016	0.47709
		34		73.82290	0.47396
		34		73.86564	0.47083
		34		73.90838	0.46770
		34		73.95112	0.46457
		34		73.99386	0.46144
		34		74.03660	0.45831
		34		74.07934	0.45518
		34		74.12208	0.45205
		34		74.16482	0.44892
		34		74.20756	0.44579
		34		74.25030	0.44266
		34		74.29304	0.43953
		34		74.33578	0.43640
		34		74.37852	0.43327
		34		74.42126	0.43014
		34		74.46400	0.42701
		34		74.50674	0.42388
		34		74.54948	0.42075
		34		74.59222	0.41762
		34		74.63496	0.41449
		34		74.67770	0.41136
		34		74.72044	0.40823
		34		74.76318	0.40510
		34		74.80592	0.40197
		34		74.84866	0.39884
		34		74.89140	0.39571
		34		74.93414	0.39258
		34		74.97688	0.38945
		34		75.01962	0.38632
		34		75.06236	0.38319
		34		75.10510	0.38006
		34		75.14784	0.37693
		34		75.19058	0.37380
		34		75.23332	0.37067
		34		75.27606	0.36754
		34		75.31880	0.36441
		34		75.36154	0.36128
		34		75.40428	0.35815
		34		75.44702	0.35502
		34		75.48976	0.35189
		34		75.53250	0.34876
		34		75.57524	0.34563
		34		75.61798	0.34250
		34		75.66072	0.33937
		34		75.70346	0.33624
		34		75.74620	0.33311
		34		75.78894	0.33000
		34		75.83168	0.32687
		34		75.87442	0.32374
		34		75.91716	0.32061
		34		75.95990	0.31748
		34		76.00264	0.31435
		34		76.04538	0.31122
		34		76.08812	0.30809
		34		76.13086	0.30496
		34		76.17360	0.30183
		34		76.21634	0.29870
		34		76.25908	0.29557
		34		76.30182	0.29244
		34		76.34456	0.28931
		34		76.38730	0.28618
		34		76.43004	0.28305
		34		76.47278	0.27992
		34		76.51552	0.27679
		34		76.55826	0.27366
		34		76.60100	0.27053
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BLADE NO.	SHOCK POSITION	UNINTERCEPTED WAVE POSITION	PERIPHERAL DISTANCE	PRESSURE RATIO
35	71.92379	72.56488		
35			67.99819	1.05033
35			68.04105	1.04673
35			68.08391	1.04316
35			68.12677	1.03963
35			68.16963	1.03613
35			68.21249	1.03266
35			68.25535	1.02923
35			68.29821	1.02583
35			68.34107	1.02246
35			68.38393	1.01913
35			68.42679	1.01563
35			68.46964	1.01256
35			68.51250	1.00932
35			68.55536	1.00612
35			68.59822	1.00294
35			68.64108	0.99980
35			68.68394	0.99668
35			68.72679	0.99350
35			68.76964	0.99032
35			68.81250	0.98715
35			68.85536	0.98403
35			68.89822	0.98090
35			68.94108	0.97777
35			68.98394	0.97464
35			69.02679	0.97151
35			69.06964	0.96838
35			69.11250	0.96525
35			69.15536	0.96212
35			69.19822	0.95899
35			69.24108	0.95586
35			69.28394	0.95273
35			69.32679	0.94960
35			69.36964	0.94647
35			69.41250	0.94334
35			69.45536	0.94021
35			69.49822	0.93708
35			69.54108	0.93395
35			69.58394	0.93082
35			69.62679	0.92769
35			69.66964	0.92456
35			69.71250	0.92143
35			69.75536	0.91830
35			69.79822	0.91517
35			69.84108	0.91204
35			69.88394	0.90891
35			69.92679	0.90578
35			69.96964	0.90265
35			70.01250	0.89952
35			70.05536	0.89639
35			70.09822	0.89326
35			70.14108	0.89013
35			70.18394	0.88700
35			70.22679	0.88387
35			70.26964	0.88074
35			70.31250	0.87761
35			70.35536	0.87448
35			70.39822	0.87135
35			70.44108	0.86822
35			70.48394	0.86509
35			70.52679	0.86196
35			70.56964	0.85883
35			70.61250	0.85570
35			70.65536	0.85257
35			70.69822	0.84944
35			70.74108	0.84631
35			70.78394	0.84318
35			70.82679	0.84005
35			70.86964	0.83692
35			70.91250	0.83379
35			70.95536	0.83066
35			71.00000	0.82753

PROFILE NUMBER IS 35

NUMBER OF DIVISIONS ARE 34

BLADE NO.
36

SHOCK POSITION
73.91999

UNINTERCEPTED WAVE POSITION
74.56288

PROFILE NUMBER

PERIPHERAL DISTANCE	PRESSURE RATIO
69.99620	1.05033
70.03905	1.04673
70.08191	1.04316
70.12477	1.03963
70.16763	1.03613
70.21049	1.03266
70.25335	1.02923
70.29621	1.02583
70.33907	1.02246
70.38193	1.01913
70.42479	1.01563
70.46764	1.01256

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1.009532
1.00612
1.00294
0.99940
0.99440
0.98927
0.98411
0.97897
0.97367
0.96879
0.96373
0.95871
0.95371
0.94874
0.94379
0.93888
0.93399
0.92912
0.92428
0.91947
0.91468
0.91444

PROFILE NUMBER IS 36

NUMBER OF DIVISIONS ARE 34

BLADE NO.
37

SHOCK POSITION
75.91799

UNINTERCEPTED WAVE POSITION
76.56088

PROFILE NUMBER	PERIPHERAL DISTANCE	PRESSURE RATIO
37	72.00000	1.05018
37	72.04274	1.04659
37	72.08548	1.04303
37	72.12822	1.03951
37	72.17096	1.03602
37	72.21370	1.03257
37	72.25643	1.02914
37	72.29917	1.02576
37	72.34191	1.02240
37	72.38465	1.01907
37	72.42739	1.01578
37	72.47013	1.01252
37	72.51287	1.00930
37	72.55560	1.00610
37	72.59834	1.00293
37	72.64108	0.99980
37	72.68382	0.99666
37	72.72656	0.99352
37	72.76930	0.99038
37	72.81204	0.98724
37	72.85478	0.98410
37	72.89752	0.98096
37	72.94026	0.97782
37	72.98300	0.97468
37	73.02574	0.97154
37	73.06848	0.96840
37	73.11122	0.96526
37	73.15396	0.96212
37	73.19670	0.95898
37	73.23944	0.95584
37	73.28218	0.95270
37	73.32492	0.94956
37	73.36766	0.94642
37	73.41040	0.94328
37	73.45314	0.94014
37	73.49588	0.93700
37	73.53862	0.93386
37	73.58136	0.93072
37	73.62410	0.92758
37	73.66684	0.92444
37	73.70958	0.92130
37	73.75232	0.91816
37	73.79506	0.91502
37	73.83780	0.91188
37	73.88054	0.90874
37	73.92328	0.90560
37	73.96602	0.90246
37	74.00876	0.89932
37	74.05150	0.89618
37	74.09424	0.89304
37	74.13698	0.88990
37	74.17972	0.88676
37	74.22246	0.88362
37	74.26520	0.88048
37	74.30794	0.87734
37	74.35068	0.87420
37	74.39342	0.87106
37	74.43616	0.86792
37	74.47890	0.86478
37	74.52164	0.86164
37	74.56438	0.85850
37	74.60712	0.85536
37	74.64986	0.85222
37	74.69260	0.84908
37	74.73534	0.84594
37	74.77808	0.84280
37	74.82082	0.83966
37	74.86356	0.83652
37	74.90630	0.83338
37	74.94904	0.83024
37	74.99178	0.82710
37	75.03452	0.82396
37	75.07726	0.82082
37	75.12000	0.81768
37	75.16274	0.81454
37	75.20548	0.81140
37	75.24822	0.80826
37	75.29096	0.80512
37	75.33370	0.80198
37	75.37644	0.79884
37	75.41918	0.79570
37	75.46192	0.79256
37	75.50466	0.78942
37	75.54740	0.78628
37	75.59014	0.78314
37	75.63288	0.78000
37	75.67562	0.77686
37	75.71836	0.77372
37	75.76110	0.77058
37	75.80384	0.76744
37	75.84658	0.76430
37	75.88932	0.76116
37	75.93206	0.75802
37	75.97480	0.75488
37	76.01754	0.75174
37	76.06028	0.74860
37	76.10302	0.74546
37	76.14576	0.74232
37	76.18850	0.73918
37	76.23124	0.73604
37	76.27398	0.73290
37	76.31672	0.72976
37	76.35946	0.72662
37	76.40220	0.72348
37	76.44494	0.72034
37	76.48768	0.71720
37	76.53042	0.71406
37	76.57316	0.71092
37	76.61590	0.70778
37	76.65864	0.70464
37	76.70138	0.70150
37	76.74412	0.69836
37	76.78686	0.69522
37	76.82960	0.69208
37	76.87234	0.68894
37	76.91508	0.68580
37	76.95782	0.68266
37	77.00056	0.67952
37	77.04330	0.67638
37	77.08604	0.67324
37	77.12878	0.67010
37	77.17152	0.66696
37	77.21426	0.66382
37	77.25700	0.66068
37	77.29974	0.65754
37	77.34248	0.65440
37	77.38522	0.65126
37	77.42796	0.64812
37	77.47070	0.64498
37	77.51344	0.64184
37	77.55618	0.63870
37	77.59892	0.63556
37	77.64166	0.63242
37	77.68440	0.62928
37	77.72714	0.62614
37	77.76988	0.62300
37	77.81262	0.61986
37	77.85536	0.61672
37	77.89810	0.61358
37	77.94084	0.61044
37	77.98358	0.60730
37	78.02632	0.60416
37	78.06906	0.60102
37	78.11180	0.59788
37	78.15454	0.59474
37	78.19728	0.59160
37	78.24002	0.58846
37	78.28276	0.58532
37	78.32550	0.58218
37	78.36824	0.57904
37	78.41098	0.57590
37	78.45372	0.57276
37	78.49646	0.56962
37	78.53920	0.56648
37	78.58194	0.56334
37	78.62468	0.56020
37	78.66742	0.55706
37	78.71016	0.55392
37	78.75290	0.55078
37	78.79564	0.54764
37	78.83838	0.54450
37	78.88112	0.54136
37	78.92386	0.53822
37	78.96660	0.53508
37	79.00934	0.53194
37	79.05208	0.52880
37	79.09482	0.52566
37	79.13756	0.52252
37	79.18030	0.51938
37	79.22304	0.51624
37	79.26578	0.51310
37	79.30852	0.50996
37	79.35126	0.50682
37	79.39400	0.50368
37	79.43674	0.50054
37	79.47948	0.49740
37	79.52222	0.49426
37	79.56496	0.49112
37	79.60770	0.48798
37	79.65044	0.48484
37	79.69318	0.48170
37	79.73592	0.47856
37	79.77866	0.47542
37	79.82140	0.47228
37	79.86414	0.46914
37	79.90688	0.46600
37	79.94962	0.46286
37	79.99236	0.45972
37	80.03510	0.45658
37	80.07784	0.45344
37	80.12058	0.45030
37	80.16332	0.44716
37	80.20606	0.44402
37	80.24880	0.44088
37	80.29154	0.43774
37	80.33428	0.43460
37	80.37702	0.43146
37	80.41976	0.42832
37	80.46250	0.42518
37	80.50524	0.42204
37	80.54798	0.41890
37	80.59072	0.41576
37	80.63346	0.41262
37	80.67620	0.40948
37	80.71894	0.40634
37	80.76168	0.40320
37	80.80442	0.40006
37	80.84716	0.39692
37	80.88990	0.39378
37	80.93264	0.39064
37	80.97538	0.38750
37	81.01812	0.38436
37	81.06086	0.38122
37	81.10360	0.37808
37	81.14634	0.37494
37	81.18908	0.37180
37	81.23182	0.36866
37	81.27456	0.36552
37	81.31730	0.36238
37	81.36004	0.35924
37	81.40278	0.35610
37	81.44552	0.35296
37	81.48826	0.34982
37	81.53100	0.34668
37	81.57374	0.34354
37	81.61648	0.34040
37	81.65922	0.33726
37	81.70196	0.33412
37	81.74470	0.33098
37	81.78744	0.32784
37	81.83018	0.32470
37	81.87292	0.32156
37	81.91566	0.31842
37	81.95840	0.31528
37	82.00114	0.31214
37	82.04388	0.30900
37	82.08662	0.30586
37	82.12936	0.30272
37	82.17210	0.29958
37	82.21484	0.29644
37	82.25758	0.29330
37	82.30032	0.29016
37	82.34306	0.28702
37	82.38580	0.28388
37	82.42854	0.28074
37	82.47128	0.27760
37	82.51402	0.27446
37	82.55676	0.27132
37	82.59950	0.26818
37	82.64224	0.26504
37	82.68498	0.26190
37	82.72772	0.25876
37	82.77046	0.25562
37	82.81320	0.25248
37	82.85594	0.24934
37	82.89868	0.24620
37	82.94142	0.24306
37	82.98416	0.23992
37	83.02690	0.23678
37	83.06964	0.23364
37	83.11238	0.23050
37	83.15512	0.22736
37	83.19786	0.22422
37	83.24060	0.22108
37	83.28334	0.21794
37	83.32608	0.21480
37	83.36882	0.21166
37	83.41156	0.20852
37	83.45430	0.20538
37	83.49704	0.20224
37	83.53978	0.19910
37	83.58252	0.19596
37	83.62526	0.19282
37	83.66800	0.18968
37	83.71074	0.18654
37	83.75348	0.18340
37	83.79622	0.18026
37	83.83896	0.17712
37	83.88170	0.17398
37	83.92444	0.17084
37	83.96718	0.16770
37	84.00992	0.16456
37	84.05266	0.16142
37	84.09540	0.15828
37	84.13814	0.15514
37	84.18088	0.15200
37	84.22362	0.14886
37	84.26636	0.14572
37	84.30910	0.14258
37	84.35184	0.13944
37	84.39458	0.13630
37	84.43732	0.13316
37	84.48006	0.13002
37	84.52280	0.12688
37	84.56554	0.12374
37	84.60828	0.12060
37	84.65102	0.11746
37	84.69376	0.11432
37	84.73650	0.11118
37	84.77924	0.10804
37	84.82198	0.10490
37	84.86472	0.10176
37	84.90746	0.09862
37	84.95020	0.09548
37	84.99294	0.09234
37	85.03568	0.08920
37	85.07842	0.08606
37	85.12116	0.08292
37	85.16390	0.07978
37	85.20664	0.07664
37	85.24938	0.07350
37	85.29212	0.07036
37	85.33486	0.06722
37	85.37760	0.06408
37	85.42034	0.06094
37	85.46308	0.05780
37	85.50582	0.05466
37	85.54856	0.05152
37	85.59130	0.04838
37	85.63404	0.04524
37	85.67678	0.04210
37	85.71952	0.03896
37	85.76226	0.03582
37	85.80500	0.03268
37	85.84774	0.02954
37	85.89048	0.02640
37	85.93322	0.02326
37	85.97596	0.02012
37	86.01870</	

BLADE NO. 3A	SHOCK POSITION 77.42120	UNINTERCEPTED WAVE POSITION 74.56208	PERIPHERAL DISTANCE	PRESSURE PAID
38			74.00200	1.005018
3A			74.04474	1.004659
3A			74.08748	1.004303
3A			74.13022	1.003951
3A			74.17296	1.003602
3A			74.21570	1.003257
3A			74.25843	1.002914
3A			74.30117	1.002575
3A			74.34391	1.002240
3A			74.38665	1.001917
3A			74.42939	1.001578
3A			74.47213	1.001252
3A			74.51486	1.000930
3A			74.55760	1.000610
3A			74.60034	1.000293
3A			74.64308	0.999980
3A			74.68582	0.999666
3A			74.72856	0.999357
3A			74.77130	0.999041
3A			74.81404	0.998727
3A			74.85678	0.998411
3A			74.89952	0.998097
3A			74.94226	0.997787
3A			74.98500	0.997479
3A			75.02774	0.997173
3A			75.07048	0.996871
3A			75.11322	0.996571
3A			75.15596	0.996274
3A			75.19870	0.995979
3A			75.24144	0.995688
3A			75.28418	0.995399
3A			75.32692	0.995122
3A			75.36966	0.994848
3A			75.41240	0.994577
3A			75.45514	0.994309
3A			75.49788	0.994047
3A			75.54062	0.993787
3A			75.58336	0.993531
3A			75.62610	0.993277
3A			75.66884	0.993027
3A			75.71158	0.992779
3A			75.75432	0.992535
3A			75.79706	0.992293
3A			75.83980	0.992054
3A			75.88254	0.991818
3A			75.92528	0.991585
3A			75.96802	0.991354
3A			76.01076	0.991124
3A			76.05350	0.990896
3A			76.09624	0.990670
3A			76.13898	0.990444

PROFILE NUMBER IS 38

NUMBER OF DIVISIONS ARE 34

BLADE NO.	SHOCK POSITION	HARMONICS	SQUARE OF FOURIER COEFFICIENTS	UNINTERCEPTED WAVE POSITION	DIFF. DB
39	79.92380	1	0.00000001	80.56488	-65.22617230
		2	0.00000000		-67.11970901
		3	0.00000002		-60.14904118
		4	0.00000004		-56.98303175
		5	0.00000001		-61.98793983
		6	0.00000000		-60.28487206
		7	0.00000001		-60.98696089
		8	0.00000001		-62.55672536
		9	0.00000000		-79.14316559
		11	0.00000000		-57.53439760
		12	0.00000001		-62.80679893
		13	0.00000001		-63.34286213
		14	0.00000000		-68.56822777
		15	0.00000010		-52.66638513
		16	0.00000001		-61.79077435
		17	0.00000001		-60.94420767
		18	0.00000003		-58.63748312
		19	0.00000000		-67.21824551
		20	0.00000000		-107.25583282
		21	0.00000000		-67.08266449
		22	0.00000003		-58.39634929
		23	0.00000002		-60.57851362
		24	0.00000001		-61.37219572
		25	0.00000012		-51.91079950
		26	0.00000000		-67.85567093
		27	0.00000001		-62.24756813
		28	0.00000001		-61.5702783
		29	0.00000005		-55.93922091
		30	0.00000000		-76.75327015
		31	0.00000002		-60.15937948
		32	0.00000003		-58.07581253
		33	0.00000001		-62.50639466
		34	0.00000003		-57.32608447
		35	0.00000015		-50.99050713
		36	0.00000011		-52.23629040
		37	0.00000004		-56.11863327
		38	0.00000025		-48.60930729
			0.01829310		0.

SAMPLE CALCULATIONS

A sample calculation for the spacing error distribution study, A-1 of Table 2, is listed here. The flow data and airfoil shapes are those listed in Table 1.

EMACH	= 1.4
THETA	= 72
NB	= 38
NS	= 90
YMAX	= 10.0
NSEG	= 5
NPRO	= 3
NSLO	= 2
MMM	= 15
ISOP	= 1
SPACG(I)	= see A-1 of Table 1
ISTAGR	= 2
STAGR(I)	= 65.0
IBSURF	= 2
COEFF(I,1)	= 0
COEFF(I,2)	= 0.17633
COEFF(I,3)	= -0.0555
SCOEF(I,1)	= 1.58855
SCOEF(I,2)	= -9.009

In the output, first the input data are printed out. After that, the pressure distribution at a given axial distance upstream of the rotor will be given. "SEGMENT NUMBER N" designate the pressure distribution at an axial distance equal to $Y_{MAX} \times N/NSEG$. Next the pressure distribution will be given blade after blade. "PROFILE NUMBER" is not equal to blade number. For example, the pressure distribution at profile number 1 means the pressure distribution between the shock waves emanating from the second and the third blades. "PERIPHERAL DISTANCE" is measured from the intersection of the bow shock emanating from the second blade and the axial distance upstream of rotor in question. "PRESSURE RATIO" is the ratio of static pressure to the static pressure at infinity. The peripheral position of the shock and unintercepted Mach wave are printed under the heading of "SHOCK POSITION" and "UNINTERCEPTED WAVE POSITION". The origin of these positions are the leading edge of the second blade. After the print-out of pressure profiles, the harmonic content of the pressure distribution are given. "HARMONICS" designates the harmonics of shaft frequency. "SQUARE OF FOURIER COEFFICIENTS" is the $(\text{amplitude of } N\text{-th harmonics} \times 2\pi)^2$. Sound power level of the harmonics, the BPF as base, is listed under the heading of "DIFF. DB".